ENGINEERING:

An Illustrated Weekly Journal.

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THE INSTITUTION OF MECHANICAL ENGINEERS.

THE sixty-ninth annual general meeting of the above Institution was held on Friday last, the 18th inst., at the Institution of Civil Engineers, Great George-street, Westminster, the President, Dr. W. C. Unwin, F.R.S., occupying the chair.

ELECTION OF HONORARY MEMBERS.

The minutes of the previous meeting having been read and signed, the President remarked that the next business before the meeting was one of rare occurrence. The Council had nominated as Honorary Members two distinguished engineers. The first was Mr. Erasmus Darwin Leavitt, of Cambridge, Mass, U.S.A., many years engineer of the Calumet and Hecla Mines, which were for long an extraordinarily valuable and prosperous property. The mines required very powerful machinery, and Mr. Leavitt had an opportunity, infrequent with engineers, of carrying out his schemes without much regard to the cost of the work. This he was able to do, as he always desired to do every piece of work, as well as was possible. Mr. Leavitt was certainly the most distinguished steam engineer in the United States, although he had done other work. The speaker had twice been with Mr. Leavitt at his home in Boston, and on the first occasion Mr. Leavitt had taken him to see one of his (Mr. Leavitt's) large pumping-engines in the Boston Water Works. There were two other engines there, built by an American firm of high standing, but these, while excellent commercial engines, as Mr. Leavitt allowed, were quite outdistanced, from the standpoints of design and economy, by Mr. Leavitt's own engine. At a later time Mr. Leavitt had shown the speaker an engine for pumping sewage, which was probably the largest and most beautifully designed of the many large low-pressure pumping-engines he (the speaker) had ever seen. Mr. Leavitt had been a member of the Institution for thirty-three years, and his election as an Honorary Member would, the speaker believed, be a distinction for the Institution and a pleasure to Mr. Leavitt.

The other Honorary Member the Council had nominated was Mr. Richard Price-Williams. Mr. Price-Williams had been a member of the Institution since 1859, or for fifty-seven years. On account of infirmity—he was approaching ninety years of age—Mr. Price-Williams was unable to be present. Mr. Price-Williams's name was associated with the beginning of the modern phase of railway engineering. Trained as a mechanical engineer, Mr. Price-Williams had, nevertheless, done admirable work in discussing the statistics and accounts of railways, and had produced rules as to expenditure which had been of great service to railway engineers; the questions of depreciation and valuation were matters on which Mr. Price-Williams had been a high authority.

The election of these two gentlemen as Honorary Members was approved by the meeting.

ANNUAL REPORT OF THE COUNCIL.

The annual report of the Council was taken as read, and, on the motion of the President, who indicated its leading points, was adopted. The following is an abstract of the report:—

The total number of names on the roll of the Institution on December 31 last was 6319, made up of 6 honorary members, 2717 ordinary members, 3026 associate members, 50 associates, and 520 graduates. The class of ordinary members showed a net reduction of 7, 80 names having been added, and 87 deducted, during the year. To the class of associate members 139 names had been added and 121 deducted, so that in this case the net increase amounted to 18. The number of associates had been diminished by 2, and the graduates by 123; but as 33 names had been added to the latter class, the net reduction amounted to 90. The total membership of the Institution had therefore diminished by 81. The number of deaths reported during the year was 70, including several members who lost their lives in connection with the war.

Early in June last the whole of the Institution's building had been taken over by H.M. Office of Works for the duration of the war, and the Institution staff was transferred to temporary offices at 11, Great George-street, Westminster. The Council desired to record the great indebtedness of the Institution to the Institution of Civil Engineers, which had kindly provided accommodation for Council and general meetings, and also granted the use of its reading-rooms and library to the members.

The total revenue for the year 1915 was 20,192*l.* 16*s.* 3*d.*, while the expenditure during the same period was 12,452*l.* 19*s.* 11*d.*, leaving a balance of revenue over expenditure of 7739*l.* 16*s.* 4*d.* The total investments and other assets amounted to 127,032*l.* 1*s.* 8*d.*, and, deducting therefrom the 34,025*l.* of debentures, a temporary loan of 7000*l.*, and other liabilities, including the sum set aside for the Leasehold and Debenture Redemption Fund, the capital of the Institution amounted to 76,373*l.* 9*s.* 9*d.* The decease, on January 27, 1915, of Mr. Robert A. McLean, F.C.A., who had audited the accounts of the Institution for thirty-seven years, was recorded with regret. Mr. Raymond Crane, F.C.A., was appointed at the general meeting held in May last to audit the accounts for 1915.

The Thomas Hawksley gold medal for 1916, the design for which was not yet completed, had been awarded to Professor H. L. Callendar, M.A., LL.D., F.R.S., for his paper on "The Steady Flow of Steam through a Nozzle or Throttle;" and premiums of 5*l.* each had been awarded to Professor A. H. Gibson, D.Sc., and Mr. W. J. Walker, B.Sc., for their paper on "The Distribution of Heat in the Cylinder of a Gas-Engine." A grant of 15*l.* had been made from the Bryan Donkin Fund to Mr. Arthur H. Barker, in aid of his research at University College, London, "to investigate a new method of determining the radiant temperature and air temperature in a room." The balance of the third triennial award had been devoted to the Steam-Nozzles and Hardness Tests Researches of the Institution. The fourth award would be made in February, 1919. Dr. William Mason (Associate Member), the recipient of the Bryan Donkin Fund awards in 1910 and in 1913, had forwarded a report on the progress of his research on the resistance of mild steel to repeated applications of cycles of alternate bending and torsion.

At the Institution's examinations, held at the Surveyors' Institution in October last, ten candidates passed the graduateship examination, and two others passed in Section I. only. Twelve candidates passed the associate-membership examination, on the results of which a prize of 5*l.* had been awarded to Mr. C. C. Pounder; Mr. F. Haile and Mr. R. J. Mitchell had received honourable mention.

The work of the Alloys Research Committee on the alloys of aluminium with zinc and copper had been continued at the National Physical Laboratory, and the importance of light alloys in connection with aeronautics had led to a Government grant for an experimental rolling-mill. The series of researches relating to the double carbides of iron, under the direction of Professor J. O. Arnold, D. Met., F.R.S., and Professor A. A. Read, D. Met., had been completed. The results of the studies on the carbides of cobalt and of molybdenum were embodied in papers on "The Chemical and Mechanical Relations of Iron, Cobalt, and Carbon," and "The Chemical and Mechanical Relations of Iron, Molybdenum, and Carbon."

The Steam-Nozzles Research Committee held three meetings, and was engaged on the design of apparatus for conducting experiments relating to the action of steam passing through nozzles and steam-turbines. The British Westinghouse Electric and Manufacturing Company offered to lend two large condensers to the Committee, and substantial progress had been made with the design of nozzle-testing apparatus. It was hoped to carry out experiments at the University of Manchester. The Hardness Tests Research Committee had been considering the design of a machine to determine rate of wear as a measure of hardness. An existing machine at the National Physical Laboratory was adapted as a preliminary procedure, but the results obtained from this machine, and modifications thereof, had not yet been satisfactory. The work of the Refrigeration Research Committee and of the Wire Ropes Research Committee had been temporarily suspended, owing to the war.

On the invitation of the Chairman of the Advisory Council of the Committee of the Privy Council for Scientific and Industrial Research, several Members of the Council attended a meeting at the Board of Education, when the Government scheme for the organisation and development of scientific and industrial research was discussed. Subsequently the Institution was invited to furnish to the Advisory Council a survey of its current and proposed researches and to submit particulars of researches for which financial assistance was required. Application has been made to the Advisory Council for grants in aid of the Alloys Research, the Steam-Nozzles Research, and the Hardness Tests Research.

The Engineer Unit of the Royal Naval Division, which was principally recruited from the members of the Institutions of Civil, Mechanical, and Electrical Engineers, had been on active service in Gallipoli. In the early stages of the war a list was compiled of the engineering and other qualifications of members desiring to obtain commissions in H.M. Army, and copies were forwarded to quarters where they were likely to be of use. The names of selected members had been put forward as candidates for commissions in the 12th King's Own (Yorkshire Light Infantry), Pioneer Companies, the Mechanical Transport branch of the Army Service Corps, and other engineering branches of the Army. Particulars of the engineering training and other qualifications of 159 members who expressed a desire to undertake engineering work in connection with the war had been forwarded to the Ministry of Munitions and other Government Departments, from time to time throughout the year. In response to an application from the Ministry of Munitions for the nomination of engineers for employment in connection with contracts for the manufacture of munitions, the Council appointed a small committee to select possible candidates, and the names of twenty-seven were submitted to the Ministry. In response to announcements in the February Journal, several designs for a mechanical bomb-thrower were received from members and submitted to the War Office. Designs had also been submitted of apparatus for destroying barbed-wire entanglements, for clearing mines from the products of the explosions, and for non-slip chains for rubber tyres of motor-wagons.

Owing to the war the usual summer meeting, anniversary dinner, and conversazione were not held. Monthly general meetings were held throughout the year, with the exception of the period from June to September. These meetings were occupied with the reading of nine papers and an address by the President, Dr. W. Cawthorne Unwin, F.R.S.; four additional papers were selected for publication in the Proceedings without discussion. Dr. Dugald Clerk, F.R.S., Member of Council, delivered the third Thomas Hawksley lecture on "The World's Supplies of Fuel and Motive Power," in London, on October 29, and, at the request of members in the provinces, had repeated the lecture in Manchester, Glasgow, and Cardiff early in November. Mr. Harry E Jones has accepted an invitation to deliver the Thomas Hawksley lecture for 1916. During the year four local meetings were held in Manchester, two in Glasgow, and one each in Birmingham, Cardiff, and Sheffield, for the further discussion of papers presented in London, and for the repetition of the Thomas Hawksley lecture.

The Calcutta and District Section of the Institution continued its activities during the session 1914-15, under the chairmanship of Captain G. H. Willis, R.E., M.V.O. At one of the meetings the chairman read the 1914 Thomas Hawksley lecture, and other meetings were occupied by the discussion of three papers; visits were also made to a number of engineering works. The membership of the section at the close of the session amounted to eighty-four.

The graduates' monthly meetings during the 1914-15 session were occupied by the reading and discussion of six papers by graduates, and by a discussion on "Pumps." Sir Robert A. Hadfield also delivered a lecture on "The History of the Metallurgy of Iron and Steel." A special prize was awarded to Mr. W. J. Drummond for his paper on "Propelling Machinery for Ships," which will be published in the Proceedings. Prizes had also been awarded to Mr. C. B. Dicksee for his paper entitled "Conditions Governing the Power of the Petrol-Engine," and to Mr. R. A. Pelmore for his paper on "Semi-Diesel Engines." Owing to circumstances arising from the war, and to the Institution's building having been taken over by H.M. Office of Works, the Council considered it desirable that the graduates' monthly meetings should be suspended during the session 1915-16.

ALTERATION OF BY-LAWS.

The President next referred to the alteration of the by-laws to meet the cases of men financially affected by the present war. The supplementary by-laws, being taken as read, were adopted, on the

motion of the President and seconded by Mr. Pendred. In our report of the previous meeting of the Institution (see Engineering, page 73 *ante*) we set out the circumstances calling for these alterations, together with the text of the supplementary by-laws framed to meet the case.

Election of Officers.

The results of the ballot-list for the election of officers to fill vacancies caused by retirements under the rules were announced by the Secretary to be as follow:—President: Dr. W. C. Unwin; Vice-Presidents: Mr. Henry Davey and Mr. Michael Longridge; Members of Council: Dr. A. Barr, Dr. H. S. Hele-Shaw, Mr. Walter Pitt, Mr. Bowman Malcolm, Mr. Vincent L. Raven, Captain H. Riall Sankey, R.E., and Mr. Wilson Worsdell. It was then proposed and seconded, and adopted by the meeting, that Mr. Raymond Crane, of 46, London Wall, London, be reappointed to audit the accounts of the Institution for the present year.

Chisels.

The paper set down for reading and discussion was one entitled "Chisels," by Mr. Henry Fowler, Chief Mechanical Engineer of the Midland Railway, Derby. This paper, which was read by the author, we print in full in another part of this issue.

Mr. Fowler supplemented his paper by certain remarks, as follow:—He felt that he should apologise for presenting so short a paper to the Institution. It might, however, be remembered that some time ago Sir Frederick Donaldson had been anxious that the experiences of engineers (who were also members of the Institution) in various parts of the country should be placed at the disposal of the whole Institution. The speaker had merely contemplated that his paper should be placed in the library, to be consulted by anyone interested, but Sir Frederick thought it was a matter which might raise discussion. The paper was written two years ago, and since that time experience at his works had not led to any modification of the treatment arranged for the chisels. For a long time he had felt that, in spite of the large increase in mechanical work, which did away with hand work, it was a pity, in view of the advanced knowledge in regard to heat treatment of steel, that something more should not be done to improve the position of the chisel, a tool so extensively used by fitters. It was simply with that object that he had put the paper together, in the hope that it would lead to a discussion and criticism of points which he could not answer satisfactorily, but which might interest members.

Sir Robert A. Hadfield was the first speaker in the discussion. He said that, beyond studying the composition of various steels and alloys for work of the kind, he had not paid special attention to the question of chisels. Not long ago, however, he had had a very interesting experience with an old-world chisel. When in Ceylon he had paid a visit to the Colombo Museum, and had there found some very extraordinary chisels, in relation to which he had contributed a paper to another institution. He had been somewhat puzzled to understand how, in those days, they got the necessary hardness for cutting purposes. On analysing the chisel in question, it was found to be practically pure iron, so far as the shaft portion was concerned, and as the chisel dated back to the early period of the Christian era, it was evident that a knowledge of some method of producing a hardened point to the chisel must have existed at that time, since it was impossible to think of wrought iron being made to accomplish the desired work. It was a curious thing to bear in mind that, in those days, they must have known the art of cementation; if they took wrought iron and embedded it in a charcoal fire, they might get a certain amount of carbon absorbed by the point, which, after quenching, would give a cutting edge. It was interesting to note that Mr. Fowler was an advocate and defender of carbon steel, and to find him, with his long experience, after having made very careful tests, bringing forward as the very best chisel one of plain carbon steel, with no special elements present. By way of suggestion, he would say it was possible that greatly improved practice might be obtained by using an alloy steel. It might be necessary or advisable for a small committee to be formed to take up the question. As everyone knew, a chisel should last as long as possible and do as much work as possible, and the speaker was positive that the question of improving the life and work of the chisel would be aided by testing a few special steels. It would be interesting if the Institution of Mechanical Engineers would form a small sub-committee to take this matter up; this would lead to considerable improvement in practice. As an example, the speaker would suggest a chromium steel, say a carbon steel with a similar carbon content to that mentioned by the author, or a lower carbon content—0.55 or 0.6 per cent. carbon—to which should be added 1 per cent. of chromium. He imagined that a chisel made of such an alloy would have a longer life, which would be a great advantage in large engineering shops. With a little more co-operation, the engineer working with the chemist and the metallurgist, great improvement might be attained. To the ordinary person a chisel seemed a very unimportant matter, but when the amount of work to be done by chisels in large shops employing thousands of workmen was considered, there was a prospect of great economy. It was, indeed, by paying attention to small details that large economies were very often effected.

In one respect—although any parallel was limited—the case of an armour-piercing projectile resembled that of a chisel: only a certain amount of work could be got out of either; and in the case of a projectile it was found absolutely necessary to employ an alloy steel. [Captain Sankey here pointed out that a projectile was a one-blow chisel.] It was, Sir Robert said, a very big blow, as would be understood on reflecting that a modern projectile struck with an energy of 40,000 ft.-tons, piercing armour-plate 15 in. in thickness in about one-thousandth of a second. For the foregoing reasons, the speaker thought that if his suggestion were carried out, improved practice would be attained after a series of tests. The author had remarked that the chisels were quenched in water, and then the whole chisel was immersed and cooled off in a tank containing oil. This the speaker considered a very important stage of the process. How long were the chisels kept in the water? When immersed in the oil, at about what temperature would the extreme point be? It would seem that it would be practically cold. He therefore assumed that some of the heat remaining in the tool body might run up to the extreme point, and thus slightly temper and toughen it. He would urge that if the small Committee he had suggested were formed, it would be desirable to see that the results of any experiments they conducted were not distributed too widely; the information should be kept at home as long as possible. Mr. Fowler had also spoken of normalising the steels used for chisels, and Sir Robert was glad to see that the author had not found any advantage in the process; he did not think normalising was likely, in the case of small bodies like chisels, to add very much to the uniformity. He presumed the steel was crucible steel. [Mr. Fowler here stated that that was so.] As the analysis showed, great care had been taken to use the purest materials—0.028 sulphur and 0.026 phosphorus; the melting had been very carefully done, and everything passed under the most minute examination. By topping the ingot and afterwards drawing it in the old type of forge—under a small steam hammer—a more uniform quality of steel would certainly be secured. The excellent results obtained by Mr. Fowler showed the advantage of carrying out works practice on a proper scale; he had, for instance, treated no less than fifty chisels at a time. That was the proper way of working, and Sir Robert thought that turning tools might be handled, with advantage, on somewhat similar lines. In conclusion, he desired to add his thanks to Mr. Fowler for the trouble he had taken, the extent of the latter's present activities being considered; no man was working harder in the good cause, as the speaker had had many opportunities of observing. Sir Robert considered the paper a model one; all could examine its definite points without having too many matters for consideration. It was the speaker's intention to send the paper round to all his foremen.

Mr. Daniel Adamson desired to ask the author whether he could trace any connection between the Brinell or scleroscope hardness tests and the duty obtained from the chisels, as the existence of such a relation was a matter of inquiry at the present time. The author had referred in the paper to tempering the tools and subsequently testing them with a file. It would be of great value to members if Mr. Fowler would elaborate that point. The paper stated that, to obtain the best results with the particular quality of steel used, a certain treatment must be carried out. Engineers would, of course, need to know, or to find out for themselves, how to treat steels which varied in composition from those recommended.

Mr. W. H. Allen (Vice President) remarked that no matter how machinery might be improved, the first instruments used by man would still be wanted. He had done considerable work in relation to the subject of the paper, on lines similar to those adopted by Mr. Fowler. The paper was difficult to debate, but the speaker had prepared some matter which showed that the practice at Bedford corresponded with that at Derby. That matter, if added to the paper, would, he thought, be of interest.

Mr. L. Pendred inquired whether the chisels mentioned by the author were all hand-chisels, or whether they were also used in pneumatic tools. In the speaker's young days, it used to be the practice for the smith to harden the tool according to the nature of the work on which it was to be used. It was possible that a chisel hardened for hand-chipping would not be suitable for use in pneumatic tools.

Mr. Druitt Halpin remarked that the author had mentioned that he was unaware of any mechanical means of testing accurately the work done by chisels. He wondered whether it had ever struck Mr. Fowler that it might be possible to use a file-cutting machine, or some modification thereof, for this purpose. In these machines there was a fairly constant blow, and the nature of the work done was as nearly as possible like that of chipping.

Mr. A. W. Marshall regarded the basal idea of the paper as an excellent one. It seemed, however, to have the effect of separating the work of the smith in forging from the hardening and tempering processes. If the smith carried out the whole process, he knew, to some extent, how to adjust the tempering to the previous work of forging. Although the hardening and tempering might very well be carried out separately, uncertainty might arise in this way due to the treatment which the steel received at the hands of different smiths who did the forging. He would like Mr. Fowler to say how the chisels were treated when they came back from the shops to be re-dressed. The broken or shortened chisel had to come back to be re-dressed; it had had a certain amount of rough usage, and it was necessary to soften and re-forge it. To what extent did this circumstance affect the systematised process of hardening? Had the author found it necessary also to standardise the system of softening or treating chisels requiring to be re-dressed?

Mr. Thomas T. Heaton inquired whether any special steps had been taken to ensure that the quality of the steel used with the system of hardening mentioned by the author was in all cases exactly alike.

Mr. J. E. Brown said that Mr. Fowler had given certain dimensions for the tips of chisels. If these varied according to usage, how were the angles on the tools given by the author arrived at?

Mr. G. T. Gillespy said that no particulars were given of the nature of the angle at the end of the tool, which was of great importance in chipping such materials as cast iron, steel, or brass. He would also ask the meaning of the term "metal tool," attached to Fig. 10, in the paper.

Mr. A. B. Jackson sought information as to the attitude of the men towards the system. It frequently happened when a tool was brought out which should be an improvement from a theoretical point of view, that the men did not like it. He had even heard it hinted that the end was broken off and re-forged by the workman in the ordinary way. Could the author state his experience of the attitude of the men towards his tools?

Mr. David E. Roberts merely wished to congratulate the author on the paper, and on the discussion evoked. They hoped, he said, to have an opportunity of discussing it at Cardiff, when, he believed, many of the practical people of the district would give them the benefit of their views.

Mr. Gentry desired to know whether, in quenching-off in the first case, the chisel was moved from about $\frac{3}{8}$ in. in depth to $\frac{1}{4}$ in. to prevent a sharp line of demarcation between the dead-hard end part and the part still heated. It appeared to the speaker that probably the secret of success was in the fact that the chisels were "let down" twice. The immersion in oil, with the shaft hot, would

have the effect of "letting down" the point somewhat; it was again "let down," of course, by being raised to the tempering temperature in the second bath. The speaker would like to know the relationship between the temperature of the ordinary tempering colour for a chisel of crucible steel—which he believed was usually a very dark straw with patches of purple—and the temperature of the second oil-bath, given in the paper as 419 deg. Fahr.

Mr. John Dewrance was rather disappointed that nobody had taken up the point raised by Sir Robert Hadfield as to the quality of the steel, for it seemed to the speaker that the chisel should be one of the best means of testing tool-steel. Of course, it had not to withstand the same temperature as a turning-tool had to do. In other respects, however, the chisel had the same duty to perform as the other cutting-tool. It would be interesting if any members would inquire into the matter, and let the Institution know, by correspondence, any particulars they could obtain as to whether people had used high-speed steel, or other improved forms of steel, for making chisels. The speaker had heard of the use of mild steel for chisels, the point being case-hardened with prussiate of potash. The theory was that, by this means, a cleaner cutting chisel was obtained than was possible with tempered carbon steel. A chisel of this kind had a very thin, dead-hard edge at the point, supported by soft steel behind. The speaker believed this practice to obtain occasionally in the case of pneumatic tools; but, not having studied the subject very closely, he did not know whether others had had greater experience.

Mr. W. S. Lockhart wished to know how the chisels were served out from the stores. He presumed they were served out as plain forgings, the men grinding them to the shape required for the work to be done. Another point arose as to the thickness of the chisel, the work done depending very much upon whether it was light or heavy. Were the men allowed to set these chisels or grind them down? What was the practice? Although, perhaps, a little outside the subject of the paper, he would ask whether the constituents of the steel would be the same for such tools as miners' drills, which were practically long chisels. An allusion had been made to the projectile as a single-blow chisel; the speaker, however, regarded the impact of a shell as more in the nature of a blow from a pick-axe. Should the steel for a pick-axe be of the same quality? Mr. Lockhart understood that, in Cornwall, some 50 or 60 years ago, at the time when wolfram was so unfavourably regarded, the smiths used to get a little from the mines, crush it on the anvil with a hammer, and throw it into the eye of the fire when hardening picks. That was a form of case-hardening, practically the Sheffield practice of to-day. The speaker had not discovered how the men found out the merits of the material, because there were several other things, such as tourmaline, in the ores; he could only suppose that they went on trying until they found something which answered. The point seemed of special interest, because wolfram was at that time not only considered valueless, but was even the *bête noire* of the miner.

Mr. G. Watson supported the suggestion made by Sir Robert Hadfield, that a committee should be appointed to deal with the important question of hand-tools, which had certainly been rather neglected in the past. It would be advantageous if a good set of standards could be provided, and if expert firms could supply small works with tools of the best quality. It was difficult for small firms to make the tools for themselves in the proper manner, as their staffs were small and the necessary appliances were not available. The speaker thought it might also be considered whether it would be worth while to weld a high-quality steel for the cutting edge on to a less expensive quality of steel for the handle; evidently the latter could not be used after it had been worn down to a certain point.

Mr. Henry Fowler then replied to the discussion. He expressed gratification at the large number of members who had taken part; but, on the other hand, he was disappointed that no one had brought forward his actual experience. He would like to say that he had not desired to write the paper or to deal with the chisel question individually, but had wanted the Institution to deal with it. He hoped, however, that if a small committee were formed, what had been done at his works, although, perhaps, not exactly in the right direction, would be beneficial to the Institution. Of course, if one shop took up the matter, only the requirements of that particular shop would be dealt with, and he did not for a moment contend that his experience would be the same as that of a neighbouring shop. He would therefore be very glad if not only the question he had brought forward, but the questions of set and fettling—here he would remark that Sir Robert Hadfield had had as large an experience as any one in this direction—could be dealt with at the same time. The question raised by Mr. Pendred, as to the pneumatic tool, was undoubtedly one on which an exchange of experience would be of the greatest value to the Institution, and to engineers as a whole. He had not tried an alloy steel for chisels, and judging from the absence of reference, other than Sir Robert Hadfield's, to the subject, he assumed that this was not unique. As to the length of time the chisel was immersed in water after first heating up, that, of course, depended upon the section; the tool would be immersed until thoroughly chilled. At the time he had written his paper he had not had any experience of the scleroscope; since then, however, he had used it extensively for the purpose of determining the hardness of a certain brass. In his works no attempt was made to ascertain the hardness of the chisel, and the matter had been mentioned in the paper merely to elicit the experience of members. If anything were done in this direction, he took it that it would be necessary to measure the hardness close up to the point and, for comparison, further up the handle. In this way it would be possible to ascertain how the hardness should vary as the softer parts were approached, in order to eliminate the chance of breakage—one of the troubles with all chisels. Mr. Adamson had asked for certain details, and these the speaker would prefer to supply by correspondence. He was much interested to learn that Mr. Allen had been working in the same direction as himself, and only regretted that Mr. Allen had been unable to go further into details and indicate any differences between the practice at Bedford and the speaker's practice; in any event, he would look forward to seeing Mr. Allen's promised contribution. In answer to Mr. Pendred, he would say that the whole of the chisels mentioned were hand-chisels. On the point raised by Mr. Druitt Halpin, testing by file-cutting machines might be of considerable advantage; and when file-makers were less busy, if someone could be induced to lend a machine, the speaker would be only too glad to try it. It would probably be necessary to carry out tests with various metals, as the material of which files were made would, presumably, be different from that on which chisels were used.

In reply to Mr. Marshall, the speaker would say that the drawing down was done in the smithy, and the chisels were then taken to the heat-treatment room. Repairs to chisels were also carried out in the heat-treatment room; that was to say, when the ends were destroyed, the repair-work was done by the smith in the room in which the heat treatment was afterwards applied. The steel was analysed for carbon only, when it came in, to see that it conformed with the specification. It was also analysed occasionally to see what the other constituents were, and to see that the sulphur or phosphorus content was not too high. Mr. Fowler regretted that he could not state the angle of the facet, but he would be glad to give the information when replying to any correspondence. The angles given in the paper had been determined by experience, and were those employed for chisels, which had been found most satisfactory. The term "metal tool" applied to a tool for white metal, although this was not signified. A good deal of chipping of white-metal surfaces was done in the speaker's works, and the chisel used for that purpose was one with a small angle and a broad face. Another question asked had turned on the attitude of the workmen; that was always a difficult matter to ascertain. If a workman, knowing that his chief was interested, was asked his opinion of a tool, he would, for obvious reasons, say that it was a fine one. The workmen had nothing to do with repairs, and a man who had a chisel which suited him would try surreptitiously to get the tool touched up for himself. In the speaker's works there were no grind-stones of any description. The tools were dealt with through the store. If a man had a damaged chisel, he would take it to the store and obtain another; this was the small shop store, from which the chisels were afterwards sent to the heat-treatment room to be dealt with. With regard to the depth of quenching, the operator put the chisel in the water and moved it backwards and forwards. It was therefore quite probable that the effect to which Mr. Gentry had referred did take place by the water washing slightly up the chisel. The speaker could not give the comparison between the temper colour and the temperature of the second bath. In reply to Mr. Dewrance, the interesting point that gentleman had raised about case-hardening was not, he thought, applicable to chisels, but the system was adopted with certain large milling-cutters. In these tools a large mass of steel, with a carbon content of about 0.4 per cent., was dealt with, and the whole was case-hardened and ground up.

BENEVOLENT FUND.

Before closing the annual general meeting, the President intimated that a meeting of the Benevolent Fund would follow immediately. It had been suggested to him, however, that before the members, who were not also members of the Benevolent Fund, dispersed he should say a few words of pleading on behalf of the fund. The present time was, no doubt, one of the worst at which to ask for further subscriptions. At the same time the Benevolent Fund was intended to aid the Institution's own members, towards whom there should exist a feeling of duty. The Benevolent Fund was started with the hope that it might attain to a capital of at least 10,000*l*. It had not reached that figure in spite of one very large subscription. Probably the fund would not grow to any great amount until some of the members left it legacies; such things were, however, windfalls, and were not to be counted on. Dr. Unwin thought, however, that it was the duty of ordinary members to contribute, without taxing themselves unduly, some smaller or larger annual sum. The fund had a capital of about 5800*l*. Only 148*l*. had been received during the year 1915 towards making good what was regarded as the deficiency in the amount of the fund, while the annual income from subscriptions was only 250*l*. For so large an Institution these figures could only be looked upon with some regret. One thing might, however, encourage members: the annual subscription had been reduced from one guinea to half-a-guinea. Membership of the fund carried with it some privileges, and it was hoped that the reduced subscription would lead to an increase in the number of members.

Mr. W. H. Patchell desired, by way of emphasising Dr. Unwin's appeal, to call attention to the case of a deceased member whose widow had recently written to the speaker, believing him to have known her late husband, requesting him to sign her form of application to the Fund. Unfortunately, Mr. Patchell had not known the husband, and although the latter had a large circle of acquaintances among members of the Institution, not one of them was a subscriber to the Fund. The widow was therefore unable to get the necessary signature for application to the Committee. He did not think this state of affairs a right one.

The proceedings then terminated.

THE LATE PROFESSOR FEUSSNER.—We regret to hear that Professor Karl Feussner died in October last, rather suddenly, a few days after his sixtieth birthday. Together with the late S. Lindrek he had a great deal to do with the invention and adoption of new electric resistance materials (manganin, &c.) for various purposes. An authority on electric measurements, he had been a member of the Reichsanstalt since 1888, and was chief of the electric department of the Technical Division.

INTERNATIONAL ENGINEERING CONGRESS, 1915.—The Committee of Management, International Engineering Congress, 1915, announces that the volume on "Mechanical Engineering" is ready for distribution and the members who have subscribed to this volume will soon receive it. The other volumes will be issued as rapidly as possible. Owing to the large amount of material to be reprinted and the thousands of copies to be bound, the work cannot be carried on with greater speed. However, it is hoped that within two months the entire set will be completed. Members who did not send in their final selections may be disappointed in not securing all the volumes they might have had in mind, and at this date the Committee has decided to close the lists for certain volumes which have been sent to the press. It may be possible to supply members who would apply at this late hour with copies of volumes which have not gone to press. Communications should be addressed to Mr. W. A. Cattell, secretary, 425, Foxcroft Building, San Francisco, California, U.S.A.

GRINDING-MACHINES.—No. XX.

By JOSEPH HORNER.

THE safety of grinding-wheels is secured first and chiefly by correct methods of mounting, assuming that the wheels themselves have been tested before being sent out, as is done by all reputable firms. This test is effected by rotating them at a speed much higher than that at which they will ever be driven when in regular service. Some typical examples of wheel mountings were illustrated in ENGINEERING of July 25, 1902. The remarks and additional examples which follow here are intended to be supplementary to the account given in that issue.

The methods of mounting are reducible to a very few principles. The first consideration is that no strain due to the actual mounting shall be set up. This is assured by the kind of contact adopted, by the shapes of the clamping-plates used, and by the fit of the spindle in the hole. In no case may the fitting be permitted to strain the wheel. It must be remembered that the tightening of a nut with a spanner may easily be severe enough to cause stress equal to or exceeding the cohesive strength of a wheel, and for this reason it is essential that the nature of the fitting shall be such that all chance of pressure of an unfair character shall be eliminated. Pressure must therefore be equally distributed over the wheel-faces that are in contact with the flanges or clamping-plates, and care must be taken that no radial stress is produced in consequence of there being too tight a contact between the spindle and the bore. The clamping-plates may also include provision for retaining the parts of a broken wheel; or this function may be allocated to the hood, with which most wheels are provided.

The simplest fitting is that of flat-faced flanges. To be secure, these must always be machined on the faces, and never be clamped directly to the wheel-faces; but washers of rubber, cardboard or of blotting-paper must be interposed. The spindle must not fit closely in the hole, nor directly in it, but a lead bush should be inserted. Neither may the fit be tight in this, but easy, without, however, any material degree of slackness. Accidents may happen through the mounting being faulty in one or other of these respects. Even a defective bushing may be dangerous. The hole in the bushing may be out of centre, or out of square with the face, the result in the latter event being that the wheel stands askew upon its spindle, when the tightening-up of the nut causes the flange pressure to crack the wheel. If the inaccuracy is slight in amount, fracture may not occur until after the wheel has been started, and then the pressure of the work may put such extra strain upon it as will produce the breakage. Or the bushing may not be trimmed off accurately with the sides of the wheel, and when the nut is screwed up, the lead, being expanded outwards into the wheel-hole, may cause a crack, or prepare the way for one.

The arrangement just described is the simplest kind of fitting used on plane disc-wheels, but though it is reasonably safe, it is not the best. The protection of a hood or guard is only a secondary form of safety device. The best protection is that which will retain the wheel itself from flying in case of fracture. In many instances this has saved life when a wheel has broken because of faulty mounting, or through a piece of work having caught between a wheel and its rest. The safety mounting usually takes the form of clamping-plates, which are adapted to hold and retain the portions of the wheel in the event of breakage.

Methods of another class that are adopted are not suitable for plane-faced discs, notwithstanding that they are safer in the event of fracture. These include dished or hollow plates with shoulders, and plates that have annular grips of cone-like section. In each case the wheel must be made of the special section to correspond, and this limits the employment of such plates.

The hollow dished form of clamping-plate may make contact with the wheel over nearly its entire face; or an annular contact only may be made, similar to that adopted on many disc-wheels. In other cases collars are shouldered to grip shoulders on the sides of the wheels. These ensure safety in the event of fracture, but as they embrace a large area, they limit the area available for grinding. Sometimes, therefore, two shoulders are used, and the plates are changed for smaller ones as the wheel wears down. The smaller diameter grips of cone-like section are not open to this objection, but they do not hold fractured pieces away from localities close to the centre.

A similar principle is employed in many ring-wheels with large holes. The bevelled recessed portions in the faces of the wheel are gripped by the corresponding parts of the flanges, as shown in Fig. 292, and are thus, in the event of fracture, prevented from flying away. The bolt-heads are protected by projecting rings on the flanges, to prevent the worker's fingers or sleeve catching in them, as will sometimes happen if the work that is being ground happens to slip away from the corner of the wheel. A practice which is adopted in some standard types of machines, such as drill-grinders and tool-grinders, is to fit and mould the wheel upon an iron centre fitted to the machine spindle, and when the wheel is worn out the centre is returned to the makers to be refilled.

Fig. 292.

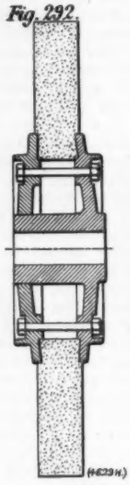


Fig. 293.

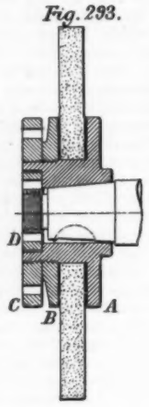
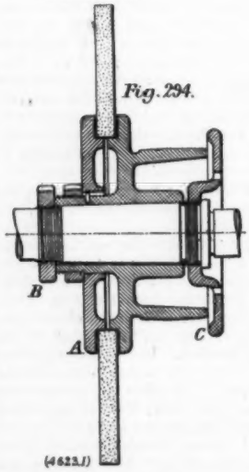


Fig. 294.



The fitting of all large clamping-plates with annular contact only is open to the objection of the waste of wheel material. Another drawback to this and the preceding methods is that every wheel of every different grade has, when changed, to be mounted directly on the spindle. To avoid these troubles the practice has now become common of making wheels with holes much larger than the spindle, and of mounting them permanently with their clamping-plates ready to be attached quickly to the spindle-nose. These are fitted in various ways. Practically they always comprise a main boss, such as shown in Fig. 293, this boss including a clamping-flange A on one side of the plate, and a boss that passes through the enlarged bore to receive the outer clamping-plate B, the latter being either screwed to it directly, or attached in some other way, and secured with the permanent nut C. The boss A makes a fit with a tapered bore to the tapered nose of the spindle on which it is keyed, and on which it is held by a flush-nut D turned with a tommy. This is one of the Brown and Sharpe fittings.

In cases where a wheel comes between two bearings it is often convenient to combine the mounting with the belt-pulley. The Brown and Sharpe universal machines have the pulley arranged as shown in Fig. 294, the clamping-flange A being set up by a slotted ring-nut. When it is desired to remove the mounting, the belt-flange C is turned with a special spanner, thus forcing the pulley and flanges off the taper spindle, the nut B having been first slackened back.

When the wheels are mounted thus on collets or sleeves, which fit the spindle interchangeably, it is unnecessary to change the wheels on their spindles directly. An example from a Bath grinder will be illustrated in the next article of this series. The Woodruff key prevents the collet from slipping, and a ring-nut fits on the screw that is let into the spindle end. In the Landis plain grinding-machines a centre is fitted (see Fig. 299), adapted to grip heavy wheels that are shouldered in the bore. An ingenious method is included for balancing these, in the shape of a pair of weights, that fit in an annular groove *b* in the sleeve, which weights may be adjusted around the groove until balance is secured, and then locked. The troubles that arise from an imperfectly balanced wheel, such as vibration and a bad surface on the work, are thus eliminated.

The cupped wheels for face-grinding form a group by themselves. These were formerly very commonly gripped on internal return flanges held

Fig. 295.

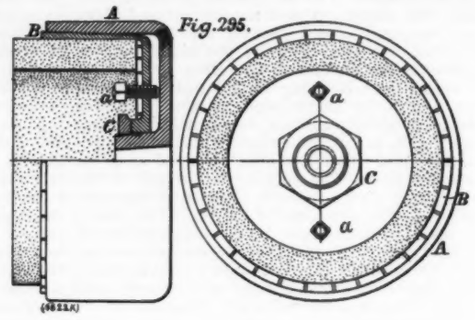


Fig. 296.

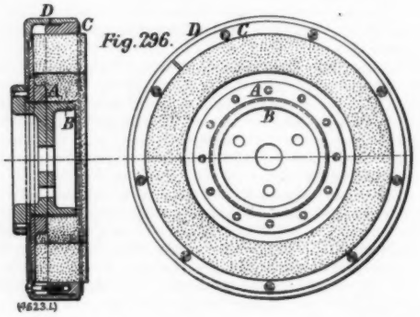
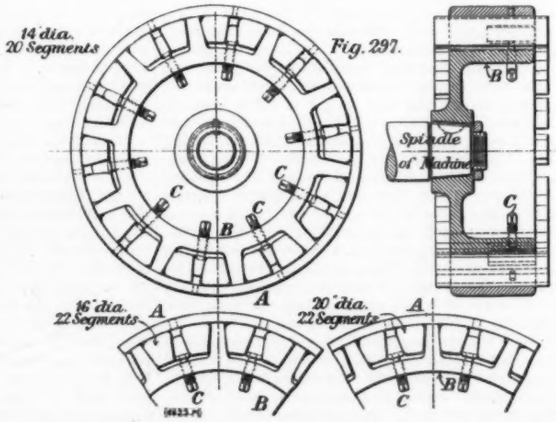


Fig. 297.



between the face-plate and an internal flange, with washers of rubber or other material to cushion the pressure. The centrifugal force in the rim acting upon the thin back imposes a strain upon the latter, and when high speeds are adopted it is safer to employ a ring-wheel without a back. To mount a cup-wheel with flanges of small diameter is only suitable for small wheels and for bevelled-edge or saucer-shaped wheels that are used chiefly for sharpening cutters. Owing to the nature of these operations, it is difficult to fit a protective guard to such wheels. But in the larger diameters

Fig. 298.

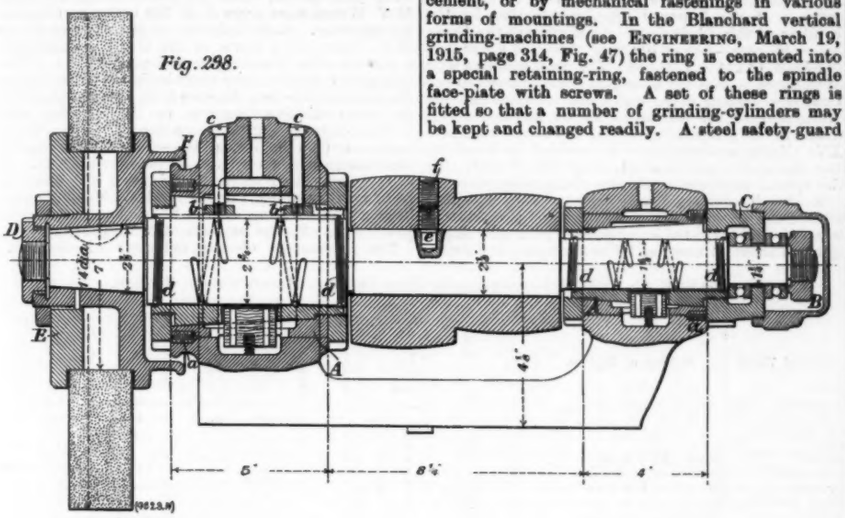


Fig. 299.

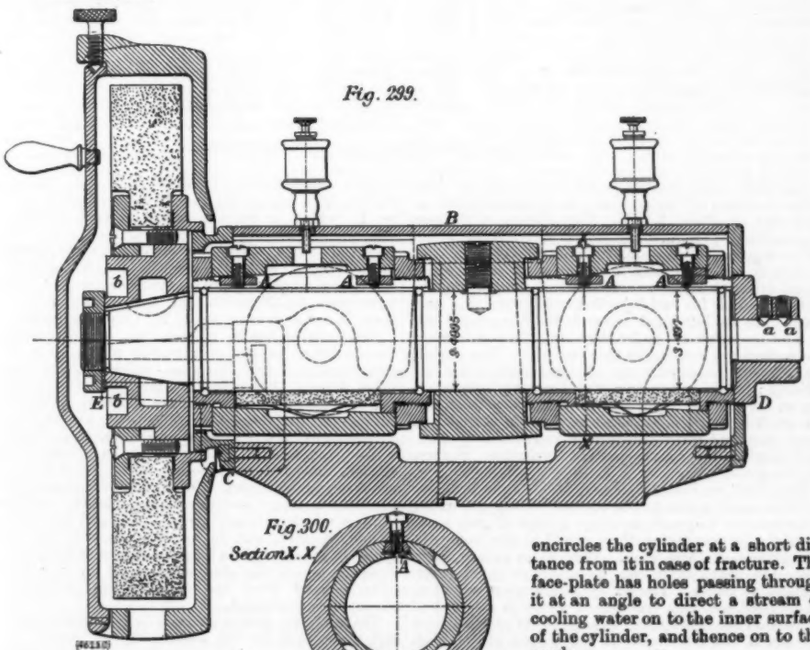
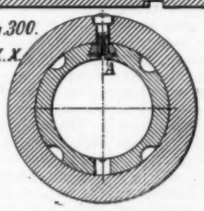


Fig 300.
Section X.X.



a guard is imperative, unless the wheel is bonded with a safety ring. Then an ordinary mounting clamps the back of the wheel, and also embraces a short portion of the diameter, but it is not a satisfactory safeguard against the flying of the pieces in case of breakage. A flanged recess, formed on the face-plate to grip the edge of the wheel, is not efficient unless it extends over nearly the whole width of the wheel, and then it seriously limits the width of the wheel that can be utilised as the face wears away. Usually, therefore, a separate encircling ring is fitted, and made adjustable backwards as the wheel wears. The usual split-ring mounting of this type gives perfect security, because it, encircling nearly the whole width, will retain the parts of a wheel after fracture. The ring is of brass or steel, split in several places to provide a little elasticity. A large ring-nut encircles it, and when this is tightened it closes the ring firmly around the periphery of the cup-wheel. By taking out countersunk screws, which hold the ring to its plate, the ring may be moved back as wear of the wheel occurs, so that never more than a moderate amount of the thickness is exposed.

The cup-wheel, however, with its back, which is practically so much waste material, is becoming displaced by the plain cylinders, which are held with cement, or by mechanical fastenings in various forms of mountings. In the Blanchard vertical grinding-machines (see ENGINEERING, March 19, 1915, page 314, Fig. 47) the ring is cemented into a special retaining-ring, fastened to the spindle face-plate with screws. A set of these rings is fitted so that a number of grinding-cylinders may be kept and changed readily. A steel safety-guard encircles the cylinder at a short distance from it in case of fracture. The face-plate has holes passing through it at an angle to direct a stream of cooling water on to the inner surface of the cylinder, and thence on to the work.

An alternative method of gripping cylinders, used by the American Emery Works, of Providence, R.I., U.S.A., and illustrated in Fig. 295, utilises wedge action. The outer casing, or shell A, encloses a split shell B, fitting it by coned surfaces. When therefore the ring-nut C on the boss of the casing is tightened, the split shell is drawn along and grips the grinding-cylinder. For removal, the nut C is loosened, and the two set-screws *a*, *a* are manipulated, so forcing the split shell out.

The Besley ring wheel-chuck is shown by Fig. 296. The grinding-ring is set forward as it wears by turning the nut A, which is in one piece with the disc behind the wheel. It is threaded to the centre B. The wheel is clamped with a split-ring C that is drawn within the coned portion of the ring D which surrounds and carries the mounting. This, being made of pressed steel, is not liable to fracture, and is safe.

A variation from usual practice is that of constructing face wheels by building them up of segments or blocks of wedge shape. This is adopted for heavy continuous work, the spaces between the blocks providing for escape of dust, while air currents tend to keep the wheel cool. The blocks are held in suitably-shaped apertures and are moved forwards in the mounting as wear takes place. Segmental grinding-wheels are liable to fracture. Yet they are desirable where free and heavy cutting is wanted. Mr. Hans Renold has designed a wheel, Fig. 297, for use in his own firm, and fitted on the Churchill vertical machine, in which the risk of breakage is eliminated by supporting each segment on three faces. The central portion is notched to receive the segments, which are confined by an outer retaining-ring A shrunk on the body B. The segments are pressed against the notches in the body, and against the retaining-ring by wedges thrust outwards by set-screws C.

When doing heavy grinding, anything of the nature of sudden impact between the work and the wheel must be avoided, as also must hard pressure, which would cause the wheel to become heated and expand. The wheel-spindles must be maintained a steady fit in their bearings. The machine itself must be secured firmly to its foundation. Whatever causes vibration or lack of balance is dangerous. Wheels must not be allowed to stand idly in water, which would throw them out of balance. They must be kept in a dry place. To maintain their efficiency, and prevent risk of heating as the result of glazing, dressing should be done frequently. Only the regular plates and washers should be used. No dirt or other foreign substances should be allowed to get between the washers and the wheel, and only the ordinary lengths of spanners should be used for tightening up.

The proper speeds of grinding-wheels, as given by the manufacturers, must not be exceeded. Spindle speeds must be varied with wheels of different diameters, and as wheels become worn down. There is a limit of safety to the relation of a wheel diameter and that of its spindle. A wheel that is out of proportion will cause undue torsional stress on the spindle, and this will react on the steady running of the wheel. Tables have been given by the Committee of the National Machine-Tool Builders' Association of the United States for the correct proportions to be observed between the two.

Some examples of recent wheel-spindles may now be illustrated as supplementary to those given in ENGINEERING of June 26, 1903, page 845.

A wheel-spindle by the Churchill Machine-Tool Company, Limited, of Manchester, is shown in Fig. 298. The journal-bearings are parallel, split, and tapered externally to fit in bushes A, A, which are parallel outside where they are gripped by the housings. This design is preferred by the firm to the usual method of boring tapered holes in the housings. Grub-screws *a*, *a* prevent the rotation of these bushes. The bearings are drawn longitudinally by the lock-nuts seen at each end. To prevent the front bearing from binding too tightly on the spindle, the steel pads *b*, *b* are inserted in the split in the front bush. With regard to these pads, it has been found that split taper bushes have a tendency to close in on the spindle at the point of severance, independently of the action of drawing in by means of the adjusting-nuts. This is an objectionable feature in the spindle of a grinding-machine, as it is essential to the true and steady running of the wheel that a uniform fit be maintained all over the surface of the bearing. It is to counteract this tendency that the top part of the bush is provided with a dovetailed slot into which two dovetailed steel pads are fitted. These are held in position by cheese-head screws *c*, *c*, which, after the bearing has been finally adjusted, are drawn up tightly. The action of the inclined faces of the pads causes the split bush to be forced apart and prevents any tendency to close it too tightly on the spindle. When wear takes place, these pads are slackened by unscrewing the screws which hold them (they are not taken out), and after the bush has been closed, are again drawn up tightly into place. The large diameter of the front journal-bearing is noticeable, as also the fact that it is much larger than the hinder bearing, the diameters of the two bearings being 2¾ in. and

1⅝ in. respectively, reminding one of the same good practice in lathe-spindles.

Lubrication is done efficiently. The lubricant is supplied through a hole in the top of each bearing, filling a well below. The oil passes up through holes in a wood float pressed upwards by a coiled spring, maintaining a felt pad in contact with the journal, whence right and left-handed spiral grooves distribute it along the bearing. A special feature of all the Churchill grinding-wheel spindles is the method of preventing oil from leaking from the bearings. This is a fine V-thread *d*, which is cut on the spindle at the extreme end of each bearing, this thread being so arranged that the direction of rotation of the spindle tends to force the oil back into the bearings, preventing leakage and creeping of oil along the spindle. This method has been in use for a considerable time, and has proved very satisfactory. End-play is taken up by the nut B at the rear, which is covered with a dust-proof cap. In ordinary transverse grinding $\frac{1}{64}$ in. of end-play is rather advantageous, as tending to prevent irregular wear of the bearings, and to assist in the distribution of the oil. When grinding to a shoulder, all end-play must be taken up. The hinder adjusting-nut C has a return flange, which forms a support to two of the collars of the ball-races. Elsewhere the spindle is free to expand longitudinally as it warms up with running. The wheel is carried in a mounting, which fits on the tapered end of the spindle with a Woodruff key, and is secured to it with a lock-nut D, having a left-hand thread. The wheel is mounted between the flanged portion of the body and a loose flange secured with a nut E. As the entire mounting can be removed more readily than changing a wheel, the firm recommends keeping a supply of wheels, each mounted on its own collet. This saves the time of changing and avoids the need for truing a wheel each time, which must be done when one is replaced by another on the same mounting. The hinder part of the wheel-mounting is prolonged at F to cover the end of the front bearing, so protecting it from the entrance of flying water and grit. A two-stepped pulley is fitted to drive the spindle, being secured with a special peg-screw *e*, which is in turn locked with a grub-screw *f*.

The Landis wheel-spindle for plain machines is shown by Fig. 299. The parallel journals, of bronze, of large diameter and great length, are noticeable. They are split in one place, to be closed in by the turning of the adjusting-nuts at the ends. The screws, with the taper wedge-pieces A—compare with the cross-section Fig. 300—are tightened to relieve the bearings of excess of pressure. A lubricator is screwed in above each bearing, and the oil is distributed from a felt-pad below, spring-supported, around spiral grooves (not indicated). A special feature of this head is the complete enclosure of the bearings and of the pulley, leaving only room for the belt, with a cover-plate B. This, with the end plates C screwed against the base, close the spindle fittings from access of dust. End thrust of the spindle is taken by the collar D at the rear in opposition to the face of the driving-pulley at the other end of the rear bearing. The two grub-screws *a*, *a*, which pull in opposition to each other, serve to push the collar towards, or draw it away from, the end of the tapered bush. The wheel, self-contained in its mounting, is held on the tapered nose of the spindle with a Woodruff key and nut E, tightened with a pronged tommy. The annular recess *b* receives weights for balancing the wheel.

Indian Railway Sleepers.—Some 460 sleepers of *terminalia tomentosa* have been treated with mixed oil by the open-tank process and laid down on the Great Indian Peninsula Railway. Sleepers previously laid down have also been carefully watched; those treated by the Powell process have been in the track the longest; all are reported free from attacks of white ants. The *dipterocarps* and pines show signs of rail-cut, indicating the need of bearing-plates, while the latter show signs of cracking and splitting, especially *pinus longifolia*. Experimental work as regards oil absorption by sleepers has been taken up in Assam in connection with indigenous woods with varying results. Gurjan sleepers were sent to England for treatment under the full-cell process with good results; other sleepers are being treated in England by the Ruping process. The whole subject of sleeper treatment appears, however, to be in an experimental stage. Minor investigations have been carried out in connection with the physical, mechanical, and seasoning properties of various timbers, while efforts have been made to find markets for certain species.

THE 4600-I.H.P. MARINE DIESEL ENGINES OF THE M.V. "CEARA."

We publish on Plates XVI., XVII., and XVIII. views of the main engines of the Brazilian submarine dépôt-ship Ceara, these engines being of unusual interest, as they are the highest-powered marine Diesel engines in actual service to-day. The ship, built and engined by the Fiat San Giorgio Company, Spezia, Italy, is of 326 ft. length by 51 ft. beam, and with a draught of 13 ft. has a displacement of 4100 tons. She was built for the Brazilian Navy as a submarine dépôt ship to act with the submarine flotilla of that navy, which comprises several submarines of the Laurenti type, constructed by the builders of this dépôt ship. As armament the Ceara has eight guns—four of 100 mm. (3.937 in.), and four of 57 mm. (2.244 in.) calibre. The chief characteristic of this ship is that the after part is constructed in the form of a floating dock, which can accommodate one of the units of the submarine flotilla, and this is well shown in the perspective view of the vessel on Plate XV. Extra accommodation is provided on board for the crews of six submarines, about 130 all told. To the special auxiliary machinery of the ship reference will later be made. The main engines, developing 2300 brake horse-power each, or on twin-screws a total of 4600 indicated horse-power, give this ship a speed of about 14 knots at 130 revolutions per minute. this engine is of the order of 110 tons, and is more rapidly applied than a "gradual load."

Before describing the main units—the cylinder, cylinder-head, and piston—reference may be made to Table I., subjoined, in which are tabulated the powers and the leading dimensions of the principal high-powered marine engines in service in merchant ships up to the present time. The ships are arranged in two groups, first those with two-cycle engines, and second those with four-cycle engines, the order under each being according to the power developed per cylinder of the main engines. The largest four-cycle engines, those of the M.V. Fionia, give a power per cylinder of 270 brake horse-power, whilst the two-cycle engines of the M.V. Wotan have a power of 300 brake horse-power per cylinder. Each cylinder of the engines of the M.V. Ceara has a power of 384 brake horse-power—a considerable increase over the next largest. That this power is not in any way obtained by overloading the main engines may be seen from the column giving the mean effective pressures in the cylinder upon a brake-horse-power basis, which with the Ceara engines is 68.5 lb. per sq. in.—a reasonable one for supercharge port scavenging for continuous duty. In fact, the only other engines in this table with a similar system of scavenging, those of the M.V. Monte Penedo, have a power rating on the basis of a brake-horse-power mean effective pressure of 78 lb. per sq. in.

The dimensions of the cylinders of the M.V.

TABLE I.—Leading Particulars of High-Powered Marine Diesel Engines.

Name of Vessel.	Builders of Engines.	Number of Engines.	Total B.H.P.	Number of Cylinders per Engine.	B.H.P. per Cylinder.	Cycle.	Cylinder, Diameter.	Piston Stroke.	Revolutions per Minute.	Piston Speed.	M.E.P. on B.H.P. Basis.	Stroke-Bore Ratio.
Two-Cycle Engines.							in.	in.		ft. per min.	lb. per sq. in.	
Ceara	F.I.A.T.	2	4600	6	384	2	24.8	35.4	130	767	68.5	1.43
Wotan	Reiherstieg (Carels)	1	1800	6	300	2	23.62	43.30	90	650	69.50	1.83
Rolandseck	Tecklenborg (Carels)	1	1500	6	250	2	20.0	36.2	130	780	67.0	1.80
Secundus	Blohm and Voss (M.A.N.)	2	2600	6	217	2	23.62	36.20	120	725	45.0	1.53
Monte Penedo	Sulzer	2	1700	4	213	2	18.50	26.8	150	670	78.0	1.45
Hagen*	Krupp	2	2300	6	192	2	18.90	31.50	140	735	61.5	1.66
Arum	Swan, Hunter (Polar)	2	1200	4	150	2	16.15	33.86	135	760	63.0	2.10
Sebastian	Polar	2	1600	6	133	2	17.70	21.26	165	585	61.0	1.20
Four-Cycle Engines.												
Fionia	Burmeister and Wain	2	2250	6	270	4	29.13	43.30	100	720	74.5	1.49
Mississippi	Ditto	2	2900	6	242	4	27.10	40.55	115	780	71.0	1.50
Elbruz	Werkspoor	2	2360	6	196	4	22.09	39.4	125	820	82.0	1.78
Juno	Ditto	1	1100	6	183	4	22.09	39.4	115	755	83.5	1.78

* There is no compressor on the main engine in this ship.

One of the main engines on the test-bed in the shops of the builders at Turin is seen in the photograph reproduced on Plate XVIII. This view is of the port engine, looking forward, and gives a good idea of the size of the engine. There are six working cylinders, in three groups of two each, and at the forward end are disposed athwartship two compressors for supplying the compressed air for fuel-injection and for starting purposes. In the left-hand corner in the foreground can be seen the water-brake for absorbing the power when the engines are running on this test-bed. The engine, being totally enclosed, gives an impression of size and solidity; but in comparison with similar plants working on the four-cycle principle, these two-cycle engines are much lighter and effect a considerable economy in space occupied when comparison is made with four-cycle engines of the same speed of revolution. Figures will be given later.

Figs. 3 to 6, on Plates XVI. and XVII., show in a clear way the construction of the engines. The six working cylinders are disposed in three groups of two each, making a longer engine than would be the case with two groups of three each. With three groups, however, the crank-shaft can be made in three interchangeable pieces. The six cylinders are mounted on an enclosed cast-iron crank-case, which is relieved of all tension stresses by the through-bolts passing from the top of the crank-case to the bottom of the bed-plate, as shown in Fig. 4. The bed-plate, also of cast iron, is in six pieces, bolted together, and is a structure well ribbed and provided with lightening holes. Ample rigidity is provided for the engine by the provision of a girder running fore and aft at the sides, beneath the floor-plates of the engine-room, as shown in section, Fig. 4. The provision of through-bolts renders unnecessary a seating for the bed-plate underneath the main bearings.

The crank-case consists essentially of a cast-iron entablature in three pieces, carrying the cylinders and serving most conveniently as a reservoir for the air delivered by the three scavenging-pumps at the back of the engine. The entablature is joined to the bed-plate by box-shaped cast-iron columns. These are of relatively light section, as they have no tension load to carry. These columns also serve to carry the main crosshead guides. The lightening effected by the provision of through-bolts will be appreciated when it is stated that the tension load due to each cylinder of Ceara's engines are:—Diameter, 630 mm. (24.8 in.); stroke, 35.4 in., giving a stroke-bore ratio of 1.43 to 1, which is quite suitable for port scavenging. The full-power rate of revolution for 14 knots with this twin-screw ship—130 revolutions per minute—gives a good propeller efficiency, together with a reasonable range of speeds of revolution for manœuvring purposes. At 130 revolutions per minute the piston speed is the moderate rate of 767 ft. per minute.

The cylinder-heads, of cast iron, are of relatively simple form, as the only valves which have to be accommodated are the fuel-valve in the centre (Figs. 4 and 5), the safety and relief-valve at the back, and the starting-air valve (Figs. 3 and 5). The scavenging-valve is separate. The three valves in each cylinder-head are of small diameter, so that the head can be spigoted into the cylinder, as shown in the section, thus reducing the height of the engine for a given strength of head. Of greater importance still, excellent cooling of the combustion-chamber is effected—a fact which will be clearly appreciated by reference to the sections, and by comparison with all other types of Diesel engines where a separate head is provided, in which the clumps of metal in way of the cylinder-head joint are objectionable where heat stresses are concerned.

The cylinder, jacket, exhaust-belt, scavenging-belt, and the pocket for the scavenging-air piston-valve are cast in one piece, obviating thus the difficult joints between the water space and the exhaust and scavenging air spaces, and securing a double wall of metal for transmitting the tension loads from the head to the crank-case. The thicknesses of metal provided are those which conduce to a more uniform distribution of stresses on the various sections. The cylinder is attached to the entablature by long and strong studs.

The action of the valve and gear for the supercharge scavenging are shown in Figs. 4 and 5. The piston-valve is large in order to prevent any restriction of the flow of air, and is light to obviate large inertia stresses. The gear driving the valve has adjustable links to allow of alignment and adjustment of the valve-setting, whilst the valve itself is actuated by a cam to give the requisite quick opening both for ahead and astern running. The cylinder-scavenging air-ports are sloped upwards to ensure more complete scavenging of the cylinder. Supercharge port-

scavenging is effected in the following manner :—On the down-stroke of the piston the scavenging-ports, being longer than those for exhaust, are uncovered first, but as the piston-valve is shut, the gases simply fill up the space of the scavenging-belt. The exhaust-ports then are uncovered by the piston, and the major portion of the exhaust gases escape, until at some small angle—about 30 deg. of revolution—before the bottom dead centre, the scavenging piston-valve opens and the scavenging air sweeps out the remaining exhaust gases. On the up-stroke the piston covers the exhaust-ports, but the scavenging air-ports are still open, and so also is the piston-valve, so that the cylinder is filled with fresh, clean air for the next compression, and this air is approximately at the scavenging-air pressure ; hence the name "super-charge scavenging."

The piston for this size of cylinder, 24.8 in. in diameter, is water-cooled. The piston-rod is hollow, and the water is pumped through an internal pipe, and discharged from a nozzle against the centre—the hottest part—of the piston-crown. The water returns through the piston-rod outside the inlet-pipe. Six piston-rings give compression tightness. The parcular form of the piston-crown, together with the dishing of the cylinder-head, are contributory to the very low fuel consumption attained by this engine (0.44 lb. per brake horse-power hour), as is later more fully dealt with. To the bottom of the piston proper is bolted and spigoted a thin shroud, which only serves to cover the ports in the cylinder. At the bottom of the cylinder are two rings to prevent oil-leakage from the cylinder-walls to the crank-case.

The piston-rod is attached to the main piston, as shown in Fig. 3, and is in two pieces, to facilitate dismantling. Each cross-head has four guides and slippers, as shown, and the guides are conveniently carried by the columns aforementioned. This spacing of the guides makes the top end-bearings very accessible. The connecting-rod is hollow for the passage of the lubricating oil under pressure to the top end-bearings and the guides. The oil, under pressure, is fed into the main bearings, thence through the hollow crank-shaft to the crank-pin bearings, and up the connecting-rod as explained. Forced lubrication has become the accepted practice for marine Diesel oil-engines, and its many advantages far outweigh any disadvantages which can be brought against the system. With steam-engines, unless very special provision be made, there is always a certain amount of gland leakage contaminating the lubricant—an objection which does not, of course, hold where oil-engines are concerned.

The engraving on Plate XVIII. shows that access can readily be obtained to all the moving parts through the large and light sheet-iron crank-case doors, whilst smaller hand-hole doors make examination whilst running quite simple.

The bearing pressures with these engines are :—For the crank-pin bearings, 1100 lb. per sq. in. ; for the crosshead bearings, 1350 lb. per sq. in. ; and for the main bearings, 550 lb. per sq. in. ; which are all normal for forced lubrication. The crank-shaft, of solid proportions, is of special quality steel.

As shown in Fig. 4, double-acting scavenging-pumps, 37.7 in. in diameter by 27.5 in. stroke, are driven by means of links with adjustable bearings and balanced levers from the crossheads of cylinders, 1, 3 and 5, numbering from the forward end. These scavenging-pumps are inverted in order to save floor space in the engine-room and to give further access to the interior of the crank-case. The dimensions are ample, ensuring a large margin of air supply. The ratio of scavenging-pump volume to main cylinder volume—1.8 to 1—is much above the average even for port-scavenging engines. The provision of three pumps to each engine, whilst giving complete immunity from total break-down, affords a steady flow of air into the scavenging-air reservoir, conveniently formed by the entablature, as already mentioned.

At the forward end of the engine are the two three-stage compressors (Fig. 6) supplying the compressed air for fuel injection and for starting. These are driven from a balanced crank. The division of this unit into two equal machines not only gives an excellent balance and an even turning moment, but minimises the difficulty of providing valves which would be reliable and give sufficient area for dealing with the large quantities of air. The construction of the compressors, which are efficiently water-cooled, follows the makers' usual practice ; they are fitted with large intercoolers. The capacity of these compressors is such as to supply all the air required for the injection of the fuel, and at the same time to give a supply for charging the starting-air reservoirs. In the perspective view on Plate XVIII. the bottle for the fuel-injection air can be seen on the ground.

With marine Diesel engines considerable interest is always attached to the means of driving the cylinder-valves and to the method adopted for ensuring reversal of running of the engine. As is almost universal practice, spiral wheels and a vertical shaft serve to drive the main cam-shaft along the tops of the cylinders and supported on bearings attached to brackets cast on the cylinder jackets. For each cylinder there are five cams in all—one scavenging-cam, ahead and an astern starting-air and fuel-injection cams. Short push-rods, with rollers at the lower ends, actuate the valve-levers, shown in Figs. 4 and 5; in the case of the fuel-valve, which opens upwards, the interposition of a short operator is necessary. The shaft along the back of the cylinder tops serves to lift the valve levers off their cams for the substitution of the ahead for the astern cam, or *vice versâ*.

The process of reversing the engine may next be described. By means of the lever to the left of the hand-wheel, as seen in the perspective view on Plate XVIII. and in Fig. 3, the vertical shaft is telescoped, so that the cam-shaft turns through an angle relative to the crank-shaft, and the cylinder scavenging-air-valve cam is set for the desired direction of rotation. Normally this operation is carried out by means of compressed air, although oil under pressure can also be used. Next, by means of a compressed-air servo-motor, controlled by the lever to the right of the hand-wheel, the back manœuvring shaft is rotated, and lifts the valve-levers from off their cams ; then this motor, by means of gearing, moves the cam sleeves of all the cylinders, so that the astern starting-air and fuel-injection cams come underneath the levers of their respective valves. Further operation of this servo-motor causes the levers for the starting-air valves to descend on to their cams, whilst a starting-air control-valve is opened, admitting air to the working cylinders. The engine thereupon revolves under air, first on six cylinders, then on three, the other three being put on to fuel. Air is cut off the three cylinders so soon as the engine has picked up on fuel, and finally all six cylinders are run on fuel. The changes are effected in much less time than it takes thus to explain them. The manœuvring gear controls all these operations, and, for all practical purposes, simultaneously with the putting of the cylinder-head fuel-injection valves into operation, the fuel-injection pumps are put into action, and the fuel-injection air is admitted to the valves. The two dials just above the servo-motor indicate clearly the progress of the various operations during manœuvring. In cases of emergency the hand-wheel can accomplish all these operations, although the time required would then be somewhat longer. Normally, reversal from full speed ahead to full speed astern can be accomplished in less than 10 seconds, which is a very much shorter time than with steam-engines of this power.

The fuel-injection pumps, one for each cylinder —six in all—are grouped together above the servo-motor, and are driven by a single eccentric off the vertical shaft. The output of these pumps can be controlled by hand, within very fine limits by the lever shown in the engraving on Plate XVIII. ; by the manœuvring gear for cutting the six pumps in and out ; by an Aspinall governor, through the rod, shown in the engraving, should the speed of revolution exceed the normal by an appreciable amount ; or, lastly, the pump for each cylinder can be individually controlled or cut out, as required.

At the forward end of the engine, as shown in Fig. 3, are the various pumps, as follow :—Two double-acting sea-water pumps for general cooling purposes, two double-acting pumps for piston-cooling, and two double-acting pumps for the main lubricating-oil system. These last force the oil through the two-way filter, seen in the perspective view on Plate XVIII., to the main pipe running along the front of the engine bed-plate. Each of these pumps is sufficient for one engine. Further, there is a fuel-supply pump for pumping from the double bottom to the fuel daily-service tanks. There is also a bilge-pump. The engine is thus entirely self-contained.

The fuel consumption on the test-bed was at full power 0.44 lb. per brake horse-power, equal to about 0.32 lb. per indicated horse-power. At half-power it was little more, being less than 0.5 lb. per brake-horse-power hour. This figure is, we believe, the lowest attained by a marine two-cycle engine, and reflects considerable credit upon the designers and the builders, especially when it is remembered that this engine has such liberally-proportioned scavenging pumps, compressors and duplicate cooling-water and lubricating-oil pumps. This fuel consumption, comparing so favourably with that attained by four-cycle engines—0.41 lb. to 0.42 lb. per brake-horse-power hour, with all the main engines' auxiliaries similarly driven from the main engine itself —shows that the higher fuel consumption of the two-cycle, so often quoted by advocates of the four-cycle principle, has little moment, especially when the saving in space and weight of the two-cycle engine is considered.

The weight complete with all gear, fly-wheel, &c., excepting starting-air bottles, of each of these engines of the Ceara is 160 tons, equal to 155 lb. per brake horse-power. For four-cycle engines of the marine type, of equally solid construction, the weight would be equal to from 250 lb. to 350 lb. per brake horse-power—for engines of the power of those in the Ceara it would be nearer the higher figure. These figures show the very considerable saving in weight with two-cycle engines, whilst the saving in space is equally great. For instance, the engine under discussion, of 2300 brake horse-power, has an over-all length, including the fly-wheel, of 30 ft. 6 in., a height from the centre line of the crank-shaft to the top of the fuel-valve in the cylinder-head of 16 ft. 6 in., and a breadth across the bed-plate of 9 ft. 6 in. and across the crank-case base of 7 ft. For comparison there may be taken a six-cylinder four-cycle engine of only 1450 brake horse-power—the most powerful four-cycle engine of which sufficient data are available—the length is increased from 30 ft. 6 in. in the Ceara to 46 ft., and the height from 16 ft. 6 in. to 18 ft., whilst the breadth is the same. These figures afford an approximate idea of the great saving in space to be achieved by the adoption of two-cycle engines of 2300 brake horse-power as against four-cycle engines of the same power when these latter come to be built.

The auxiliaries in the engine-room are concerned chiefly with maintaining the submarine flotilla attached to this dépôt ship in a ready and efficient state. Firstly, two 150-kw. Diesel generator sets are installed, and are illustrated in Fig. 2, on Plate XV. As can be seen, these auxiliary engines follow broadly the same principles of design and operation as the main engines. Each has four working cylinders of 11.8 in. in diameter by 12.2 in. stroke, and runs at 300 revolutions per minute. The current generated serves to charge batteries in the submarines and to drive the auxiliaries of the dépôt ship, chief amongst which are two electrically-driven air-compressors, one compressing up to 1000 lb. per sq. in. for engine-starting, and the other for compressing from the 1000 lb. per sq. in. up to 2250 lb. per sq. in. for the torpedo air-reservoirs of the submarines. A steam-driven compressor working to 100 lb. per sq. in. is also installed, and serves for testing the tightness of the hulls of the submarines. There are two electrically-driven centrifugal pumps for supplying fuel and lubricating oils to the submarine storage-tanks. The only steam-driven plant in addition to the compressor, already referred to, is a small stand-by air-compressor, and both are run from a ship's steam-heating boiler. For repair-work a workshop is provided.

The Ceara, it will be recognised, is a most complete unit of a special type, and represents the latest practice in Diesel engine work, of which the Fiat San Giorgio Company have now had many years of experience. Scotts' Shipbuilding and Engineering Company, Limited, Greenock, have for some years been building, under licence from this company, engines of this type, chiefly for naval work, and they only wait the opportunity to direct their energies towards the application to the mercantile marine of oil-engines of the type which we have illustrated and described.

PERSONAL.—Messrs. H. Mackay and Co. inform us that they have removed from 4, Southampton-row, W.C., to Norfolk House, Laurence Pountney-hill, London, E.C. —Messrs. John Wright and Co., of Eureka Works, Thimble Mill Lane, Birmingham, have appointed Mr. Alexander Morrison, of 12, Waterloo-street, Glasgow, their agent in Scotland for gas-heated furnaces.

THE PANAMA CANAL.—Another year's experience has been acquired in connection with the Panama Canal. During its fiscal year the canal was used by 1068 vessels, having an aggregate gross and net tonnage of 5,416,787 tons and 3,843,035 tons respectively (Panama Canal measurement), and carrying 4,969,792 tons of cargo. The number of east-bound vessels which passed through the Canal was 530, representing 2,125,735 tons, while the number of west-bound vessels was 538, of an aggregate burthen of 2,844,057 tons. All but 27 vessels passed over the five following trade routes:—Coastwise route of the United States ; route between Europe and the west coast of the United States and Canada ; route between Europe and South and Central America ; route between the Atlantic coast of the United States and the Pacific coast of South and Central America ; and route between the United States and Australia, New Zealand, and the Extreme East. These routes were used by nearly 97 per cent. of vessels carrying cargo. The United States coastwise route was used by 335 vessels, with a total net tonnage of 1,305,291 tons of cargo. The route between Europe and the west coast of the United States and Canada was used by 142 ships, carrying 834,899 tons of cargo. Traffic between Europe and South and Central America occupied 155 vessels, carrying 503,672 tons of cargo. Traffic between South and Central America engaged 206 vessels, carrying cargo amounting to 947,871 tons ; and the route between the Atlantic seaboard of the United States and the Extreme East occupied 118 ships, carrying 725,712 tons of cargo. The tolls levied during the fiscal year, not including the United States Government vessels, amounted to 4,343,384 dols. The current expenses for working and maintenance were 4,112,550 dols., leaving a surplus of earnings over expenses of 230,833 dols. This total, however, was a wholly inadequate return upon the great sum sunk by the United States in the construction of the Canal. Of the vessels which used the Canal last year, 481 were American, 464 British, 41 Norwegian, 35 Chilian, 24 Danish, 18 Swedish, 7 Dutch, 6 Japanese, and 6 Russian, the balance of 16 being made up of Peruvian, French, Honduran, Italian, Nicaraguan, and Panamanian ships.

DETAILS OF THE "PEERLESS" MOTOR TRUCK.

CONSTRUCTED BY THE "PEERLESS" MOTOR-CAR COMPANY, CLEVELAND, OHIO, U.S.A.

Fig. 1. LONGITUDINAL SECTION THROUGH MOTOR AND CLUTCH.

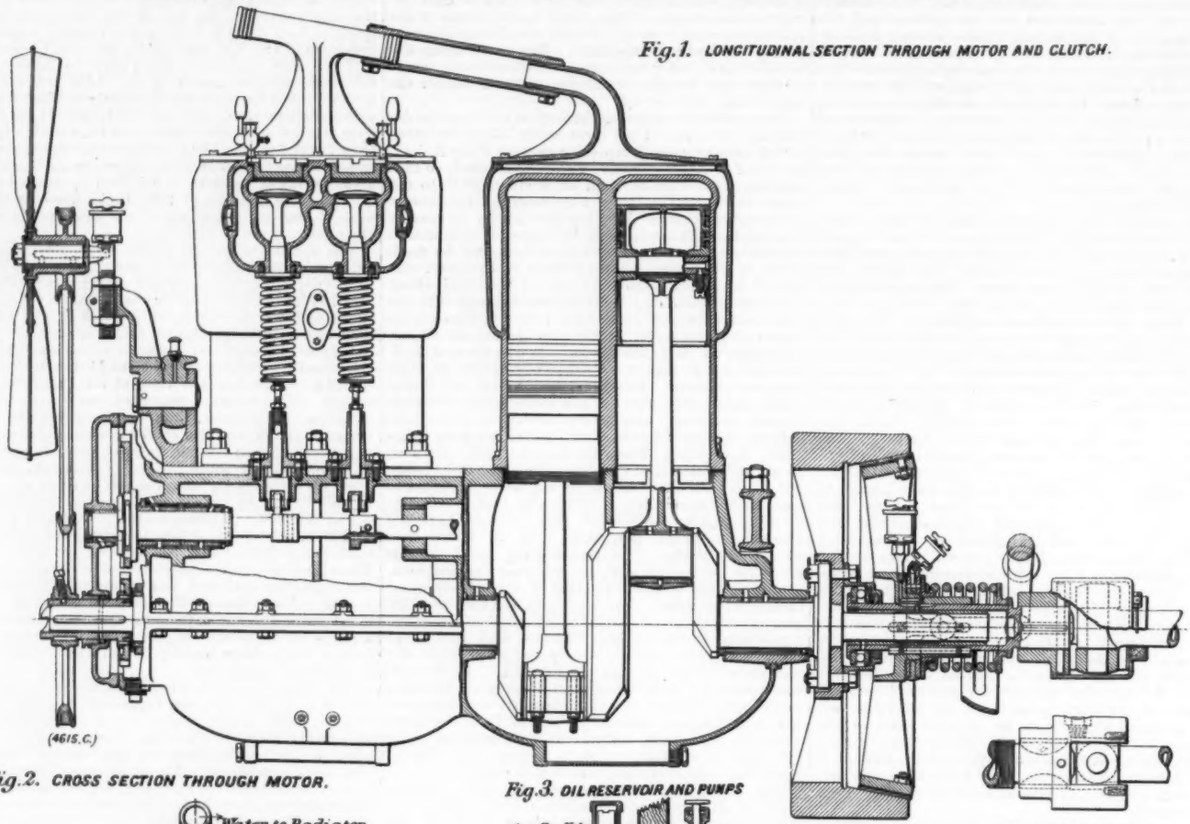


Fig. 2. CROSS SECTION THROUGH MOTOR.

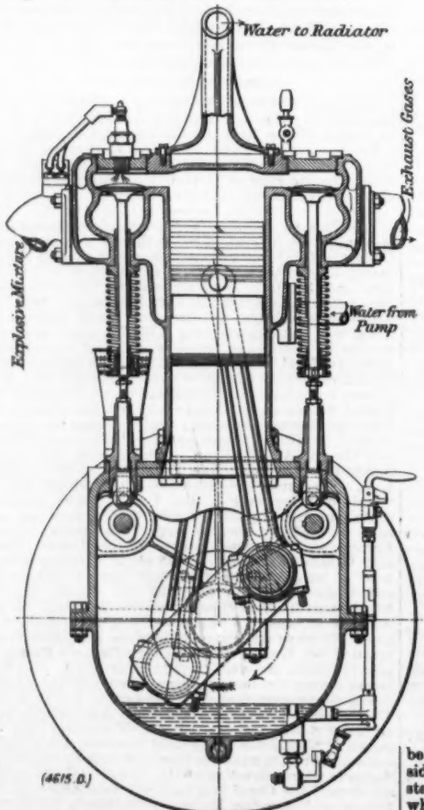


Fig. 3. OIL RESERVOIR AND PUMPS

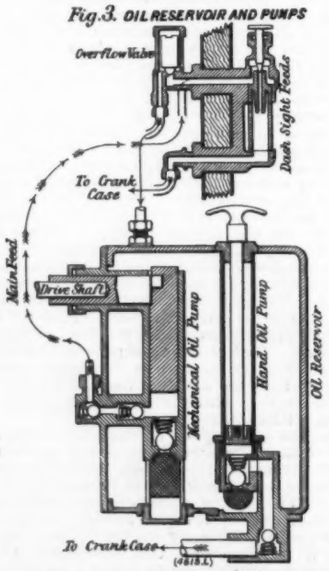
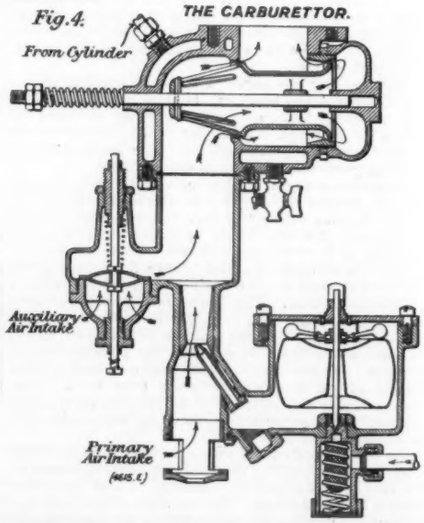


Fig. 4. THE CARBURETTOR.



THE motor-trucks of which we give illustrations above and on pages 183 and 184, manufactured by the Peerless Motor-Car Company, of Cleveland, Ohio, are being handled in this country by Messrs. Gaston, Williams and Wigmore, Limited, Alexandria House, Kingsway, London, W.C. They are of four sizes—namely, 3-ton, 4-ton, 5-ton, and 6-ton, and each size is made with two lengths of chassis, in the one case for long and bulky articles, and in the other for short and heavy articles. The wheel-base, however, is in each case the same—namely, 12 ft. 7 in.

The trucks may be had with a dumping mechanism of either a hand-screw-power type or a chain-power type. With either type the load may be dumped by the driver simply pulling a lever at his side. The load may be dumped while the truck is stationary in about 40 seconds, or it may be done slowly while the truck is moving forward, so as to spread the material as is required in laying road metal, &c. The action of the truck moving forward in each case returns the body to its normal position.

The motor, shown in Figs. 1 and 2, above, is of the four-cycle type, and has four water-cooled T-type cylinders, cast in pairs. The dimensions of the cylinders are 4½ in. bore by 6½ in. stroke, giving 32 horse-power according to R.A.C. rating, but giving actually on the brake 40 horse-power. The cooling system is by pump circulation and fan, the fan being driven by a V belt and a pulley fixed on the extension of the crank-shaft. The radiator is of the "Peerless" design, and is mounted on springs, which relieves it from road shock, and consequently reduces liability of leakage.

The crank-case is in two parts; the upper part carries all the bearings, while the lower part acts as an oil receptacle. The crank-shaft is machined from a solid one-piece forging, and, as shown in Fig. 1, is mounted on three plain long bearings. The front bearing is 3½ in. long, the centre one 3⅜ in. long, and the rear one 4½ in. long. The crank-pins are 2½ in. in diameter. The cam-shafts, which are gear-

DETAILS OF THE "PEERLESS" MOTOR TRUCK.

CONSTRUCTED BY THE "PEERLESS" MOTOR-CAR COMPANY, CLEVELAND, OHIO, U.S.A.

Fig.5. DUPLEX MAGNETO SYSTEM WITH BUZZER.

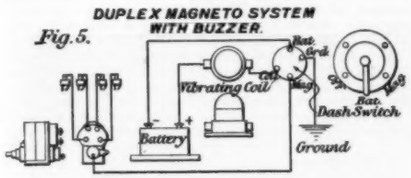


Fig.6. MAGNETO WITH VIBRATING COIL.

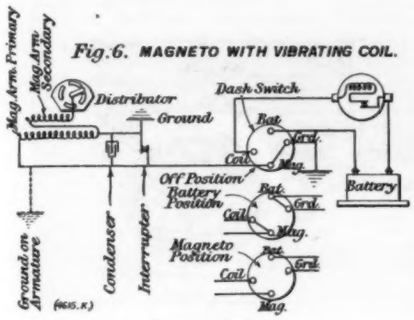


Fig.7. STEERING COLUMN AND WHEEL.

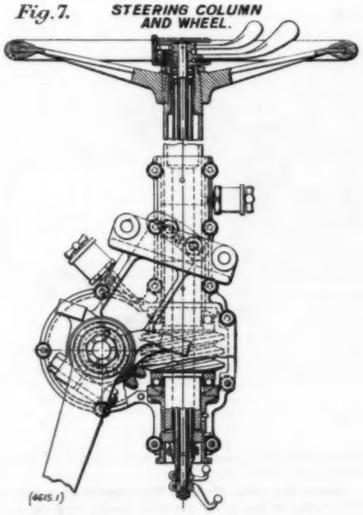


Fig.8. SECTION THROUGH TRANSMISSION GEAR

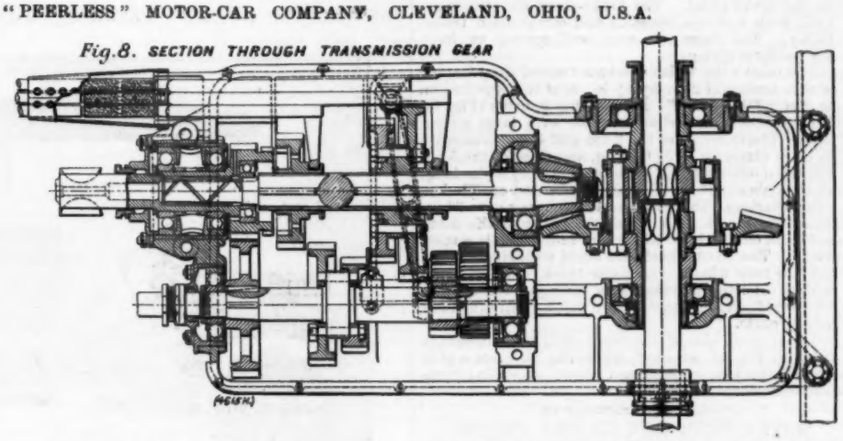
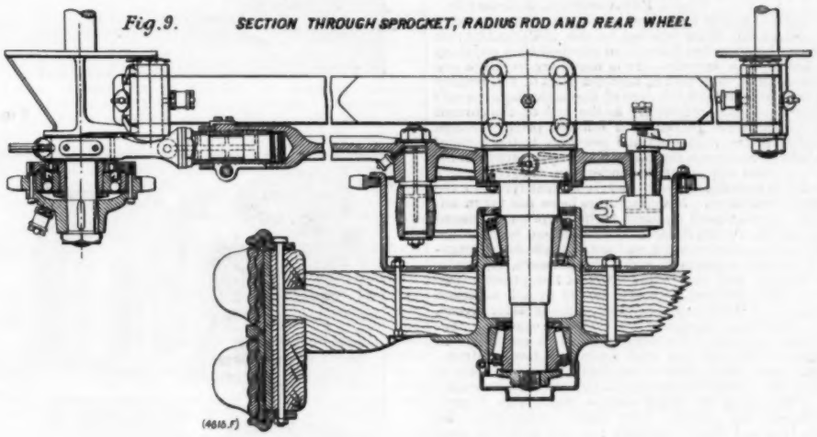


Fig.9. SECTION THROUGH SPROCKET, RADIUS ROD AND REAR WHEEL



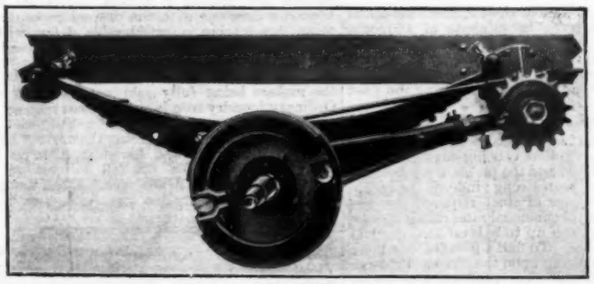
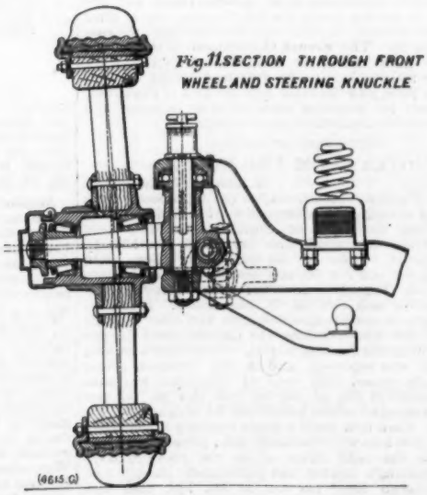


FIG. 10.

Fig.11 SECTION THROUGH FRONT WHEEL AND STEERING KNUCKLE



driven, have separate cams keyed and pinned in position. The gear-case for the cam-shaft gearing is a separate chamber, and is partly filled with oil for lucrication of the gears.

The motor-lubricating system is of the constant-level splash type. The oil is fed to sight drip-feeds mounted on the dash, as shown in Fig. 3, by means of a positive pump, which draws its oil from an oil-reservoir mounted on the left side of the motor. Any excess of oil supplied to the sight-feeds returns to the oil-reservoir, as shown in the illustration. The oil which passes the sight-feeds is led to the motor. Stand-pipes are provided in the lower portion of the crank-case, as shown in Fig. 2, for establishing the correct oil-level, which the pump afterwards maintains.

The carburettor, Fig. 4, is very accessible, and is of the automatic type, and is water-jacketed. The throttle-valve is of the double-beat type. The ignition system used is the Bosch dual, in which accumulators are used for starting and the magnets for running; diagrams of the wiring are shown in Figs. 5 and 6. The control is by spark and throttle-levers, which are shown in Fig. 7, and also by an accelerator pedal; the maximum speed, however, is regulated by a governor. Fig. 7 also shows the general construction of the irreversible worm steering mechanism.

The power is transmitted from the motor to the gear-box through a leather-faced cone clutch with cork onsets, the construction of which is very clearly shown in Fig. 1. The gear-box, which also contains the differential gear, is shown in Fig. 8, above. Four speeds forward and one reverse are provided by a gear-box of the selective type, the high gear being a direct drive. The gears are of large diameter and ample width, and the shafts are mounted on ball-bearings. The jack-shafts which fit into the differential have hexagon ends; the other ends are carried on a double row of self-aligning ball-bearings. On the other ends of these shafts are fitted the sprockets for the final chain-drive to the rear wheels.

Radius-rods extending from the rear axle to the jack-shaft outer bearings are provided to keep the centres of the chain-wheels a constant distance apart, irrespective of the movements of the road-wheels. These radius-rods are of forged steel, with bronze bushes at either end, and are also provided with universal joints and with means for adjusting the chains. They also carry the emergency brake mechanism, as shown in Figs. 9 and 10. The emergency brakes are of the expanding-shoe type, and are operated by a side-lever through an equalising-bar. The service

brakes are mounted on the jack-shafts, near the gear-box, and are of the contracting-band type; they are actuated through equalising levers and rods connected to the brake-pedal. The brake-shoes and bands are lined with a woven asbestos and composition brake-lining. The chassis is very well sprung on long, semi-elliptic springs.

The front axle, which is a heat-treated drop-forging with a section of 2 in. by 3½ in., is of the type known as the "Elliott jaw." The steering-knuckle (Fig. 11) is of good design, and is provided with large grease-cups. The axle-pins of the 3-ton and 4-ton chassis are 2½ in. in diameter by 3½ in. long, and those of the 5-ton and 6-ton chassis are 2½ in. in diameter by 4½ in. long. The wheels are of wood, and are mounted on Timken roller-bearings. The 3-ton and 4-ton chassis have 36-in. front wheels and 40-in. road-wheels, while the 5-ton and 6-ton chassis have 38-in. and 42-in. wheels respectively. The front wheels are fitted with single tyres, and the rear wheels with twin tyres, both of solid rubber. All the moving parts throughout the truck are bushed, and grease-cups are fitted to all the minor moving parts.

A very good idea of the track with short chassis is given in Fig. 12, annexed, while Fig. 13 gives a plan view of the long chassis, and shows very clearly the extension of the frame.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, February 9

DETAILS as to iron and steel orders, voluminous as they are, possess but little interest to the trade public; an enormous business has become so common that anything else would be a surprise. It is necessary to make one condition clear, and that is, that the mills of the country have been able to take full care of domestic requirements for months ahead, practically to the end of the current year, at moderate rather than inflated prices, though at higher prices than obtained previous to the general onslaught of European demand; this ample provision for all actual steel requirements under the conditions is a remarkable accomplishment, and it is gratifying to the domestic consumers. Manufacturers have not taken advantage of European demand to boost prices unnecessarily, but the future is dark, because needs, both foreign and domestic, are advancing, and as an indefinite prolongation of the war appears in sight, the pressure, especially from abroad, will continue. Even at the present time there is the greatest pressure as yet to fill munition contracts, and crude and semi-finished material for export.

The enormous expansion in traffic is crowding railroads into the market for steel cars, orders ranging from as high as 3000 from one road down to a few hundreds. Several roads have ordered locomotives; since early in January the United States Steel Corporation has averaged new orders close to 60,000 tons a day. The French Government has ordered forty-eight locomotives; the Iukens Iron and Steel Company has contracted for steel to build a 5000-ton annexe to its immense plant, and has succeeded in placing orders for 500,000 tons, and is after more. One concern in Ohio took 350,000 tons; the rest was divided up. The French Government is also endeavouring to place orders for 4,500,000 steel forgings for 6-in. shells; about half to be delivered during the last half of this year, and the other half the first of next year. The pressure for munition material must increase, and frantic efforts are made to expand capacity.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—After the depression of last Wednesday morning the afternoon market made a bound upwards, and 1500 tons of Cleveland warrants were dealt in at 96s. 9d. twenty-one days, and 96s. 10d. to 97s. one month, while at the close cash sellers were quoted 96s. 8d. and 97s. 1d. one month. Idleness again prevailed on Thursday morning, with closing sellers' quotations 97s. cash and 97s. 6d. one month. Prices reacted sharply at the afternoon session, and after a small business of 500 tons was done the market closed 1s. per ton down from the morning's level. On Friday a certain irregularity was reported, and in the forenoon prices were a trifle easier, 1500 tons of Cleveland warrants changing hands at 95s. 6d. per ton cash and 96s. 3d. one month. At the close sellers quoted 96s. 9d. cash and 96s. 3d. one month. Cash iron made a slight recovery in the afternoon, and 1000 tons were dealt in at 96s., prices at the close standing at the same figure as on the previous day. Monday morning's market was particularly strong, and prices advanced 10½d. per ton to 96s. 7½d. cash and 97s. 3d. one month. Only 2000 tons were dealt in, and at the close sellers quoted 96s. 10½d. cash and 97s. 4½d. one month. Prices rose further in the afternoon, and after being done at 97s. 6d. one month's iron closed with sellers at 97s. 7½d. Closing sellers' prices were 3d. per ton over the morning's level, and 1s. 1½d. per ton on the day's dealings. A small business of 500 tons was reported. Yesterday morning the market was again strong, 1500 tons of cash iron changing hands at 98s. 6d. per ton, with closing sellers' quotation 98s. 9d.—an advance of 1s. 7½d. over the previous day's level. This represents the highest figure reached during the recent activity. Some business was done at odd dates, 98s. per ton being realised for fifteen days, and 98s. 1d. for sixteen days, and at the close 99s. 3d. was quoted by sellers for one month's iron. Prices went back rather sharply in the afternoon, and after realising 98s. per ton, one month's iron dropped at the close to 97s., with cash sellers at 96s. 6d., this showing a decline of 2s. 3d. per ton from the morning's level. This was totally eclipsed this morning, however, when a sensational drop of 7s. per ton took place from yesterday. A turnover of 1500 tons was dealt in, for which 92s. eight days and one month was realised, and at the close sellers quoted 89s. 6d. cash and 90s. one month.

Sulphate of Ammonia.—No new development has taken place in regard to the trade in sulphate of ammonia during the past week, other than that consumers are being urged to place their orders very speedily, so that these may be completed with the least possible delay. Prices still remain at the same level as during the past two or three weeks.

Scotch Steel Trade.—There is practically nothing new to record in connection with the local steel-making industry; all the available effort is being devoted to war work of one kind or another, and the pressure for delivery is undiminished. Prices keep strong; indeed, the exceptional demand for all classes of steel required by the Government, added to the phenomenal rates ruling for raw material, has brought values up to a level not touched during the past forty years. To find a parallel, one must go back to the days following upon the Franco-Prussian War, when iron and various other products and manufactures rose to famine prices. Export orders are coming well to hand, but as week succeeds week, ordinary mercantile business is set further into the background. With the Government control of the shipping trade, which is to come into force on March 1, matters should naturally become a little easier for manufacturers, who have had to contend with insuperable difficulties during the last few months. Everything is on a rising scale:—Ship-plates are 13*l.* 5*s.* and upwards; boiler-plates are 14*l.* 5*s.*, and even more; and angles are off and on about 14*l.*—all less the usual 2½ per cent. discount

Malleable-Iron Trade.—The malleable-iron trade stands practically where it did a week ago—the same ceaseless activity, the same pressure for delivery, the same difficulty in getting arrears run off. With the rapid advance of pig-iron prices, and the restricted supply of billets available, the values of malleable iron are gradually stiffening. Without any effort on the part of the makers, orders come flowing in, even although the cheapest grade of "Crown" bars cannot be had below 13*l.* 10*s.* per ton, while the best quality is fully 5*s.* to 7*s.* 6*d.* per ton over this figure, less 5 per cent.

Scotch Pig-Iron Trade.—The utmost strength continues to prevail in the local pig-iron trade, and prices are still on the upward trend. So great is the demand that makers are finding it almost impossible to get their booked orders out with the desired promptness, and in consequence there is considerable delay with later inquiries. Both home and export trade is steadily expanding, and the improvement in the latter is very marked. Hematite, still at 115*s.*, is coming away well, some of the makers being fully sold out for some time ahead. Ordinary foundry iron is also in great request. A further advance has now taken place in the price of makers' (No. 1) iron, the following being the current quotations:—Calder, Summerlee, and Langloan, 120*s.* per ton; Clyde and Gartsherrie, 122*s.* 6*d.* (all shipped at Glasgow); Eglinton, 115*s.*, and Glengarnock, 120*s.* (both at Ardrossan); Dalmellington, 115*s.* (at Ayr), and Shotts, 120*s.* (at Leith).

SHORTAGE OF MACHINERY IN RUSSIA.—The British Vice-Consul at Ekaterinburg reports that in Ural mining works a great dearth of machinery in general is now beginning to be very seriously felt, and fears exist as to whether Allied and neutral Powers will be able to replace the tremendous quantity of machinery that Germany formerly supplied to Russia. Not to mention new enterprises, the machinery which is at present in use, owing to the difficulty of obtaining spare parts, is likely to be run out, so that practically all current businesses will require new machinery after the war. The demand for catalogues and specifications in the Russian language has never been so acute as it is at the present time. Russian buyers are at a loss to find out whence to obtain prompt and reliable information as to where special requirements may be bought. Great preparations, says the *Board of Trade Journal*, from which we take this information, should be made by all firms anxious to share in business in the Russian market after the war. Travellers having a good knowledge of the Russian language, as well as a technical knowledge of machinery, should be sent out to the Ural mining works, where the Russians would be only too glad to give them every assistance.

THE "PEERLESS" MOTOR TRUCK.

CONSTRUCTED BY THE "PEERLESS" MOTOR-CAR COMPANY, CLEVELAND, OHIO, U.S.A.

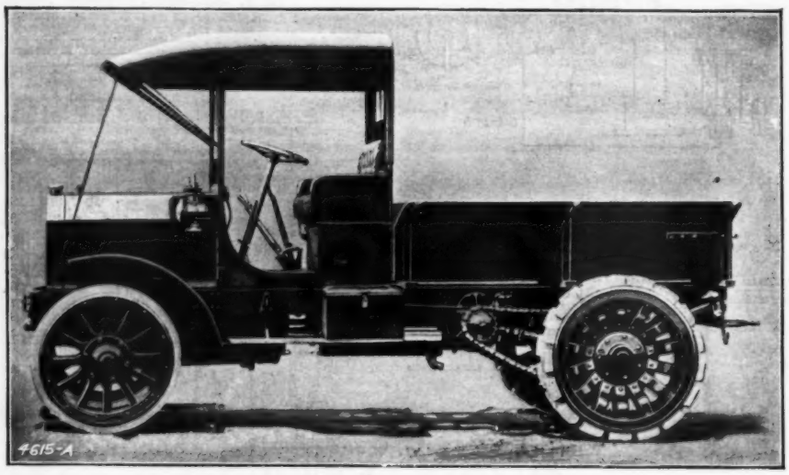


FIG. 12.

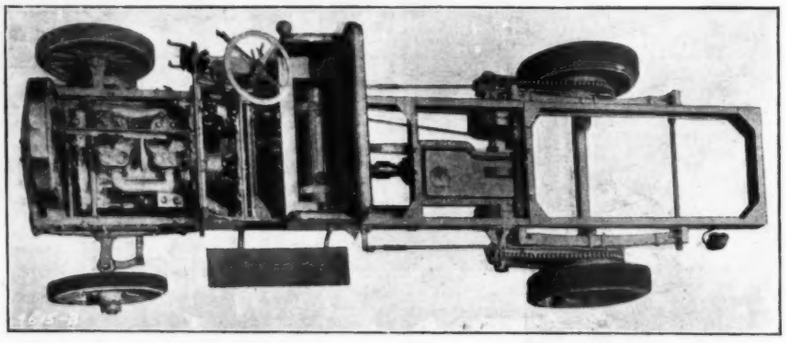


FIG. 13.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

South Yorkshire Coal Trade.—There is no falling off in the demands for all classes of manufacturing fuels, but merchants are experiencing the greatest difficulty in securing supplies, even to fulfil orders under contracts with controlled and munition establishments. Complaint is made by coalowners that the bad working of the railways is one of the principal causes of the shortage of supplies. There is a lack of wagons. These are, it is stated, allowed to accumulate on the sidings during the week, rushed into the collieries on the Sunday, and thus create a congestion of the lines. As a result it is impossible to obtain a regular service for delivery, even though these wagons are conveying coal for munition works, and are therefore supposed to have precedence over other coal traffic. Coalowners and merchants are making representations on the matter to a local committee, appointed on the direction of the Ministry of Munitions, which is exercising a careful oversight on distribution of coal locally. The effect of the shortage is seen in the quotations. So strong is the position that instances are cited where the Coal Price (Limitation) Act, has been tacitly ignored, as it is found impossible to obtain coal at the standard rate. There is no loose fuel on the open market. The supplies to Allied countries continue great, with France a good customer. Neutrals are not able to obtain full requirements, as the export licence prohibitions are carefully observed. Slacks are scarce and high figures are being paid. Coke is coming forward in much larger quantities, and all demands are being fairly well met. Quotations:—Best branch hand-picked, 20s. 6d. to 21s. 6d.; Barnsley best Silkstone, 17s. 6d. to 18s. 6d.; Derbyshire best brights, 17s. 6d. to 18s. 6d.; Derbyshire house, 16s. to 17s.; best large nuts, 15s. to 16s.; small nuts, 14s. 6d. to 15s. 6d.; Yorkshire hards, 16s. 6d. to 17s. 6d.; Derbyshire hards, 16s. to 17s.; best slacks, 11s. to 12s.; seconds, 9s. 6d. to 10s. 6d.; smalls, 8s. to 9s.

Iron and Steel.—Although prices for iron and steel remain abnormally high, the demand is so great that consumers have had to accept sellers' terms almost at sight, in order to obtain supplies. In many cases, however, prices are not so extraordinarily inflated as in the preceding few weeks, when the maxima were freely exceeded in all grades. Derbyshire foundry qualities are priced at 88s. up to 91s., delivered in Sheffield, while forge is slightly cheaper than last week. Lincolnshire iron, of all descriptions, is marked locally at 91s. to 91s. 6d. Hematites have greatly fluctuated in price. West Coast types are now obtainable here at much lower rates than those to be paid for East Coast. Whereas East Coast brands are marked at 143s. to 146s., West Coast are, in some instances, quoted as low as 138s., though there were cases in which 143s. was paid. Scrap iron, which is forward in large quantities, is freely asked for, and though big prices have to be paid, these are held to be reasonable in proportion to those for new material. This scrap is being rapidly melted down at local works. Billets remain scarce and buyers promptly avail themselves of any new supplies, so complete is the shortage of stocks. There have recently been a good many American inquiries for high-speed steel, which is infinitely cheaper here than in the States. The operation of export licences prohibits any greater business being done, for the demands of the Allied countries continue to be exceedingly large. There is a good market for files, twist drills, and small tools generally, and manufacturers are not able to cope with all orders. Last year it is estimated Sheffield received an accession of about fifteen more electric furnaces, making the total twenty-five. The whole subject of electric installation has been revived, and it is felt that this system possesses advantages over the crucible in the turning out of small castings, which are increasingly required for a number of trades. Overseas orders continue to arrive for large quantities of cutlery, tools, shovels, and files, and the War Office have placed contracts for electro-plate, nickel silver, tools, clasp-knives, table-knives and forks, and surgical instruments in enormous numbers. There is evidence that the export trade is increasing, for the Cutlers' Company have now to deal with a larger number than ever before of applications for exemption from export prohibitions.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Once more the much-discussed question of fixed maximum quotations is the all-absorbing topic in commercial circles. Intimation is understood to have been made that these rates must be adhered to, with the result that much excitement has prevailed on 'Change here this week, and the market has been very disturbed and unsettled. The maximum price fixed for No. 3 g.m.b. Cleveland pig for home consumption is 82s. 6d., but sales to customers have been made at a considerably higher figure. As much as 99s. has been named as the export price, and sales have occurred at a little below that. The f.o.b. rate for shipment to foreign countries may now be put at 90s.; but several merchants are holding off altogether, and refuse to name a figure. What rates could be obtained for the other qualities for export is difficult to ascertain; but it is stated that for home use no quality must be sold at above 82s. 6d. Very little iron is available for sale for early delivery, and some fear is expressed that it will be found very difficult to fully satisfy home requirements in the near future.

Hematite Pig-Iron.—There is little passing in East Coast hematite pig-iron, due to the fact that there is practically none purchasable for supply before the third quarter of the year. The forward quotation for Nos. 1, 2, and 3 remains at 140s. The maximum was fixed at 122s. 6d., but this was on the assumption that foreign ore could be bought at 34s., and coke at 28s. delivered at the furnaces. For every advance of 1s. in ore 2s. could be added to the price fixed for hematite, and for every rise of 1s. in coke 1s. 2d. could be added to the hematite price. These arrangements, with other small additions, fully justify the quotation of 140s. for mixed numbers of hematite.

Stocks and Shipments of Pig-Iron.—The stock of pig-iron in the public warrant stores here now stands at 87,217 tons, 84,407 tons of which is No. 3 Cleveland, and 2810 tons other kinds of Cleveland iron deliverable as standard. Since the beginning of the month the stock has been reduced by 8637 tons. Shipments of pig-iron from the port of Middlesbrough to date this month amount to 31,288 tons, as compared with 24,981 tons to the same date last month, and 6976 tons for the corresponding part of February, last year.

Foreign Ore.—Inactivity continues to characterise the foreign-ore trade, due to the facts that consumers are carrying fairly large stocks, and that very ample supplies are still arriving on contracts. As a consequence, users are not in the market to buy. On the other hand, sellers still take a very firm stand and prices are rather more than maintained, the position having stiffened as the result of higher freights. Market quotations are now based on fully 40s. 6d. ex-ship Tees for Rubio of 50 per cent. quality. Freights Bilbao-Middlesbrough are fully 24s. Fixtures have been made at that figure, and 24s. 6d. is also named. Imports of foreign ore to the Tees to date this month amount to 61,905 tons.

Coke.—Local consumers of coke report further business at the fixed maxima for home use—viz., 28s. at the ovens for average blast-furnace kinds, and up to 30s. 6d. at the ovens for sorts low in phosphorus; but with the heavy demand for export at much higher rates, there is some apprehension of difficulty in securing adequate supplies for local use in the near future. Manufacturers continue to complain considerably that the price limits to home consumers have been fixed too low, and some effort is being made to have the conditions relaxed.

Manufactured Iron and Steel.—So far as is ascertainable there are no new developments in the finished iron and steel industries. Manufacturers are kept as busily employed as ever on Government work, and very little indeed is heard of ordinary commercial business. The following are among the principal market quotations:—Common iron bars, 13*l.* 10s.; best bars, 13*l.* 17s. 6d.; double best bars, 14*l.* 5s.; treble best bars, 14*l.* 12s. 6d.; iron ship-plates, 11*l.* 10s.; iron ship-angles, 13*l.* 10s.; iron ship-rivets, 15*l.* 10s.; packing iron (parallel), 9*l.* 10s.; packing iron (tapered), 11*l.* 10s.; steel ship-plates, 11*l.* 10s.; steel ship-angles, 11*l.* 2s. 6d.; steel joists, 11*l.* 2s. 6d.; steel sheets (singles), 14*l.*; steel sheets (doubles), 15*l.*; steel strip, 13*l.*; steel hoops, 13*l.* 10s.; and heavy steel rails, 10*l.* 17s. 6d.—rails net f.o.b., steel shipbuilding material and steel joists net at works, and all other descriptions less 2½ per cent. discount f.o.b.

Tees Bridge Iron Company's Works.—Negotiations are understood to have been practically completed for the sale of the Tees Bridge Iron Works, comprising three blast-furnaces at Stockton-on-Tees, to Messrs. Pease and Partners, Limited.

NOTES FROM THE SOUTH-WEST.

Cardiff.—Stormy weather has somewhat interfered with the operations of exporters, but in most cases vessels have been ready to meet immediate needs. While buyers have been able in a few cases to obtain price concessions, colliery-owners have shown an almost general reluctance to adopt such a course, as they have heavy Government and other orders on their books. The concessions occasionally made by sellers have related principally to smalls. The best Admiralty large steam-coal has been, to some extent, nominal; secondary qualities have made 35s. to 36s.; best bunker smalls, 18s. to 18s. 6d.; and cargo smalls, 12s. to 13s. per ton. The best household coal has brought 23s. to 24s. per ton; other quotations have been as follow:—good households, 21s. to 22s.; No. 2 Rhondda large, 30s. to 31s.; and No. 2 smalls, 23s. to 24s. per ton. The latest quotation for patent fuel has been 33s. to 35s. per ton. Special foundry coke has made 46s. to 47s.; good foundry coke, 40s. to 45s.; and furnace coke, 33s. to 36s. per ton. As regards iron ore, Rubio has been quoted at 37s. to 39s. per ton upon a basis of 50 per cent. of iron, and charges, including freight, insurance, &c., to Cardiff or Newport.

Western Trade Matters.—The directors of the Western Wagon and Property Company, Limited, recommend a dividend of 10 per cent. for 1915; this company's Cardiff works, plant, and machinery stand on the books at 3369*l.*; 377 wagons let on simple hire at 6763*l.*, and an unmatured balance due on purchase-hire, at 32,128*l.*—Lord Muir Mackenzie has been appointed independent chairman of the South Wales Conciliation Board.—At the annual meeting of the Swansea Gas Light Company, the chairman (Mr. J. Glasbrook) said the company, acting under instructions from the Minister of Munitions, was recovering toluol, which was an essential ingredient in the manufacture of high explosives; the quantity recovered and the remuneration received were comparatively small. The chairman also incidentally called attention to the fact that South Wales coal was not so suitable for gas-making purposes as coal produced in the Midlands or the North of England, the latter producing about 2500 more cubic feet of gas per ton handled. The company will make next month a further advance of 2d. per 1000 cub. ft. in the price of the gas; there will, however, be no additional charge to large consumers.—The Local Government Board has refused an application of the Merthyr Town Council for permission to raise a loan to cover the cost of erecting 160 workmen's dwellings at Penydarren.—The directors of the Cardiff Collieries, Limited, recommend a dividend of 15 per cent. for 1915; the output of coal was seriously reduced by the enlistment for the war of a large number of the company's miners; a profit of 53,765*l.* was, however, realised for the year.—The Port Talbot Railway and Dock Company has declared a dividend of 9 per cent. for 1915. Since new outer lock-gates have been completed, the sluicing capacity has been greatly increased, and this has brought about a substantial decrease in the cost of dredging the entrance channel and maintaining its width and depth; the deep-water area of the docks has also been considerably extended. An extension of the Talbot Wharf has been completed and equipped with hydraulic cranes, and three new coal-conveyors, one of which is movable, have worked satisfactorily. The total net income for 1915 was 121,780*l.*—The South Wales Mineral Railway is being worked by the Port Talbot Railway and Docks Company.—The steamer Belfort has been recently purchased by the Bathampton Steamship Company, Limited, for 68,000*l.*—The Town Line, London, Limited (Messrs. Hendersons, Sons and Co., managers, Cardiff), have purchased the Benshaw for 31,000*l.*—The exports of coal from Bristol Channel ports in January, 1916, compared as follows with corresponding exports in January, 1915:—January, 1916: Cargo coal, 1,524,993 tons, against 1,697,777 tons; bunker coal, 292,307 tons, against 424,426 tons.—The Great Western Colliery Company, Limited, divides upon its ordinary capital for 1915 at the rate of 15 per cent. per annum; for 1913 the dividend was at the same rate; for 1911, 1912, and 1914 the distribution was 10 per cent. per annum.—The net income of the Great Western Railway Company for 1915 was 5,847,435*l.*, as compared with 5,873,509*l.* in 1914.—The directors of D. Davis and Sons, Limited, report a balance of 264,716*l.* available for distribution for 1915, this includes 64,589*l.* brought forward; the directors recommend a dividend of 10 per cent. upon the ordinary capital for 1915, carrying forward 60,720*l.*—The dividend of 10 per cent. proposed for 1915 compares with 10 per cent. distributed for 1912 and 1914, and 15 per cent. paid in 1913.—The Neath and Brecon Railway Company will give its preference stockholders a dividend of 2½ per cent., carrying forward 2111*l.*—At the annual meeting of the Barry Railway Company at Cardiff on Friday, Earl Plymouth, who presided, said new works in course of construction included five coal-tips, increased hydraulic power and siding accommodation; the outlay on new works for the past twelve months had been 52,500*l.* Earl Plymouth added that shipments at Barry during the past twelve months had been 10,389,908 tons, as compared with 11,572,373 tons in 1914.—The dividend of the Redcroft Steam Navigation Company, Limited, for 1915 is to be at the rate of 20 per cent. per annum, free of income-tax; this last condition is, of course, a consideration in these times. The profits of the company during the five years ended with 1916 inclusive were:—1912, 4633*l.*; 1913, 30,047*l.*; 1914, 21,396*l.*; 1915, 15,482*l.*; and 1916, 117,953*l.*

POSSIBILITIES OF BRITISH TRADE WITH RUSSIA.—From 1898 to 1902, says the *Board of Trade Journal* of the 17th inst., Germany furnished, on an average, about 35 per cent. of Russia's foreign imports, which were valued at 61,000,000*l.* per annum. During the same period the share of the United Kingdom was about 19 per cent. In 1913 Russia's imports from abroad were valued at roughly 145,000,000*l.* Of this amount Germany supplied nearly 50 per cent., while the share of the United Kingdom amounted to less than 13 per cent. Even if due allowance is made for the fact that the Russian Customs returns include under German imports certain British goods which come into Russia *via* the German frontier, the natural conclusion from these figures is that during the last twenty years Germany has increased her trade with Russia at the expense of the United Kingdom. The article in the journal in question then calls attention to the need of organised preparation in the United Kingdom for increasing our trade with Russia, and suggests various methods for reaching that end. The article should be read by all British firms desirous of developing their connection with the Russian markets.

INDIAN RAILWAY ACCIDENTS.—The fatalities on Indian railways in the ten years ended with 1913, inclusive, were:—

Year.	Fatalities.	Year.	Fatalities.
1904	1156	1909	1931
1905	1295	1910	1837
1906	1614	1911	2078
1907	1834	1912	2145
1908	2137	1913	2338

It will be seen that the number of persons killed was larger in 1913 than in any preceding twelve months; but account should, of course, be taken of the increased mileage which is now being worked. Of the whole number killed in 1913, 268 were passengers, 480 were railway servants, and 1590 were trespassers, suicides, &c. The proportion of trespassers and suicides, it will be observed, was large. This accounts for the fact that the number of persons injured upon Indian railways in 1913 was smaller than the number killed outright, the proportion being 2142 and 2338. The number of fatalities upon the principal Indian systems in 1913 was:—Bengal and Nagpur, 232; Bengal and North-Western, 154; Bombay, Baroda and Central India, 119; East Indian, 428; Eastern Bengal, 229; Great Indian Peninsular, 328; Madras and Southern Mahratta, 120; Oudh and Rohilkund, 150; and North-Western, 321.

BAR-CUTTING-OFF MACHINES.

CONSTRUCTED BY MESSRS. J. BUTLER AND CO., ENGINEERS, HALIFAX.

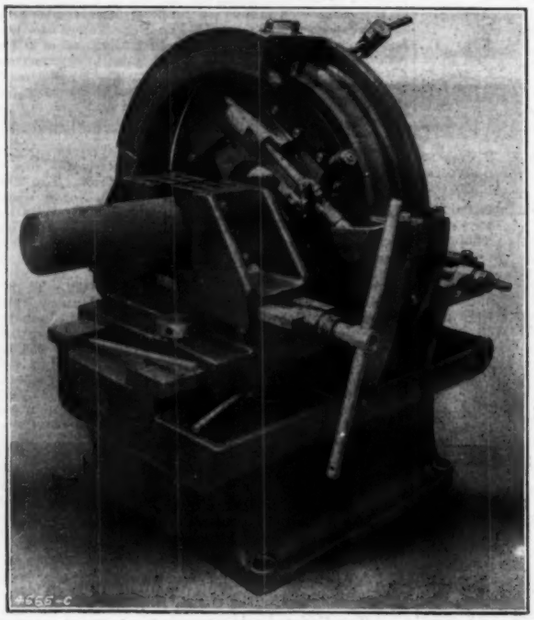


Fig. 1.

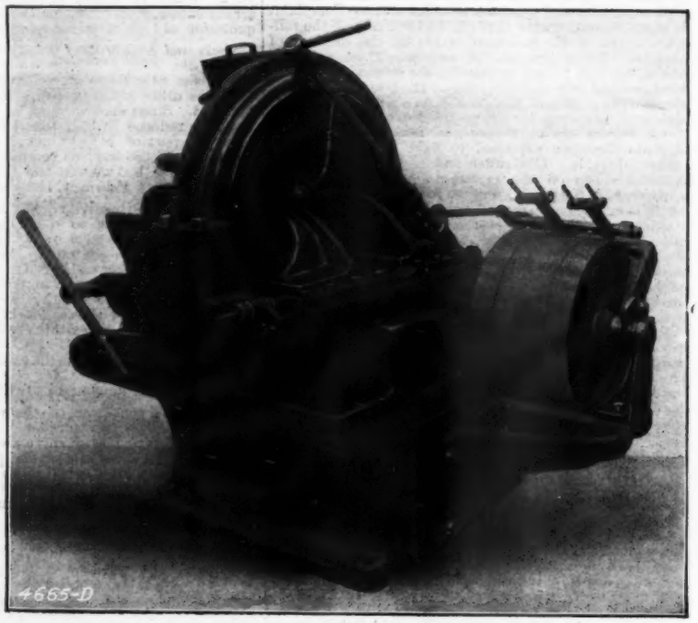


Fig. 2.

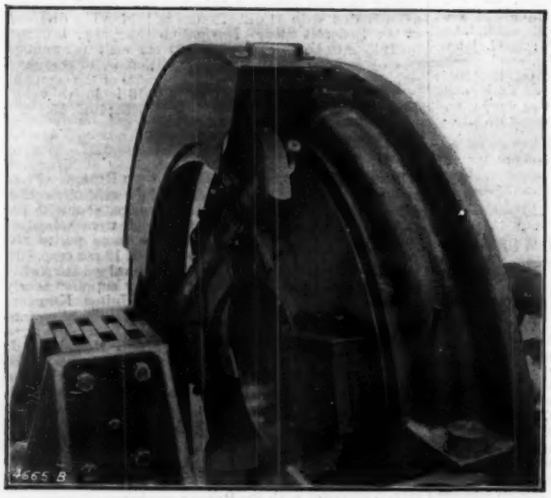


Fig. 3.

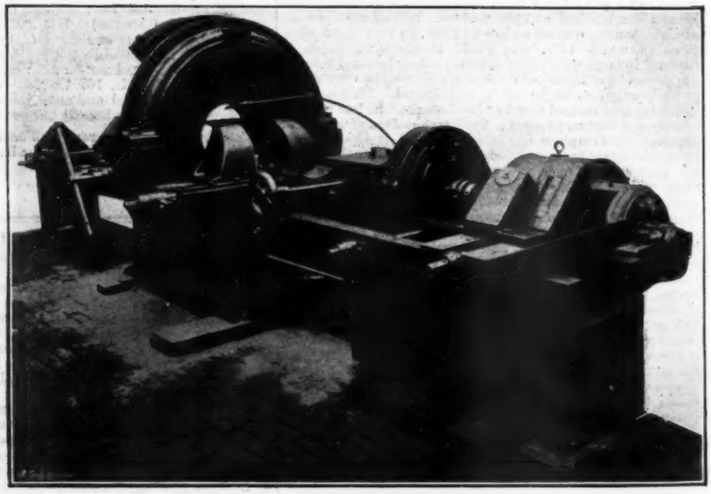


Fig. 4.

The cutting off of steel and iron bars, both round and square, has now become a very important operation in many works, and it is necessary that it should be done both rapidly and accurately if cheapness of manufacture is to be attained. Interest therefore attaches to the very efficient cutting-off machines we illustrate on this page. These machines are made in three sizes, of which we illustrate two. The smallest size, that for dealing with bars from 3 in. to 4½ in. in diameter, is on the same principle as the other two which we illustrate, but is naturally lighter and smaller, as it does not need the same guides and supports for the bar as do the larger ones. The machine illustrated in Figs. 1 and 2, above, is suitable for bars for shells up to 9.2 in. in diameter, while that in Figs. 3 and 4 is suitable for diameters up to 14 in.

All these machines have been developed from an earlier pattern which the makers, Messrs. J. Butler and Co., of Victoria Iron Works, Halifax, have employed with success for many years in their own shops. As will be seen, the bar stands still, while the tool, which is a simple straight parting tool, revolves around it. This tool is carried on a revolving disc, and is mounted on a steel slide provided with a web-piece, on which the cutting tool is clamped, without any overhang. This tool and the supporting web feed automatically into the bar at each revolution. There is a feed-arresting device which automatically stops the feed when the bar is cut down so far that it will readily break.

As shown in Figs. 1 and 2, the machine is driven through one fast pulley and two loose pulleys. Two speeds are thus obtained with two belts, without any complication. The disc is driven by means of a spur-wheel on the outside through a pinion on the pulley-shaft.

Figs. 3 and 4 show the largest size of machine. It carries two cutting-tools, one for parting, and the other, of V shape, for nicking, both tools being operated simultaneously from the same feed motion. This machine is provided with a roller bench on each side, to support the bar both before and after cutting. The roller supports are self-centring. The vices at each side of the disc are also self-centring. This machine can be conveniently driven by an electric motor, preferably of the variable-speed type. The time required for cutting bars is given in the subjoined table:—

No.	2 in.	5 in.	6 in.	8½ in.	9½ in.	12 in.	14 in.
	m. sec.	min.	min.	min.	min.	min.	min.
1	1 45	5	9	—	—	—	—
2	2 0	6	6	12	25	—	—
3	—	9½	11½	16	18½	20	35

Cotton in Massachusetts.—The commencement of 1915 found Massachusetts fine-cotton mills working only to from 65 to 75 per cent. of their capacity, but as foreign goods became scarce business increased, prices advanced, and 1916 has found all the mills on full time and supplied with orders at good prices. The fine-cloth mills of Massachusetts had a fair year in 1915, and yarn mills had an exceptionally good one, owing to so much cotton yarn being used in automobile tyres. The total dividends paid in 1915 amounted to 3,112,300 dols., or 7.83 per cent. upon the capital invested. In 1914 the average dividend paid was 4.76 per cent., and the average for the previous ten years was 8.37 per cent.

THE BRAZILIAN DIESEL-ENGINE-PROPELLED SUBMARINE DÉPÔT SHIP "CEARA."

(*For Description, see Page* 180.)

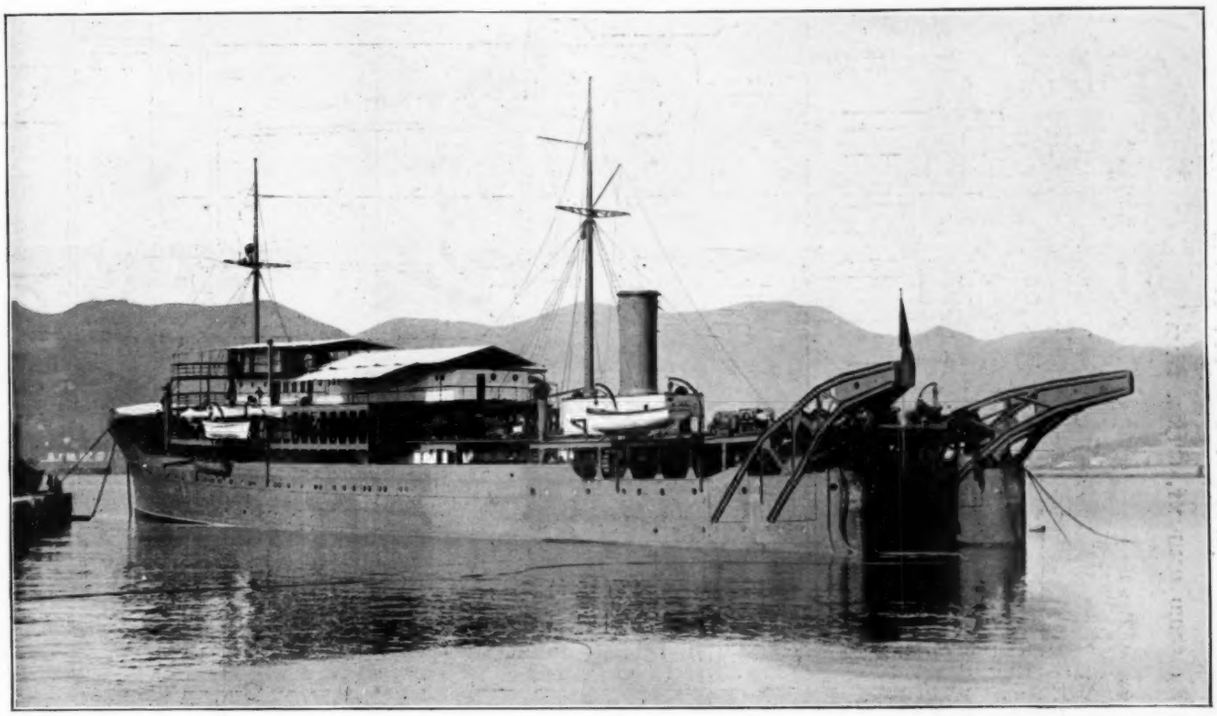


Fig. 1. The Vessel.

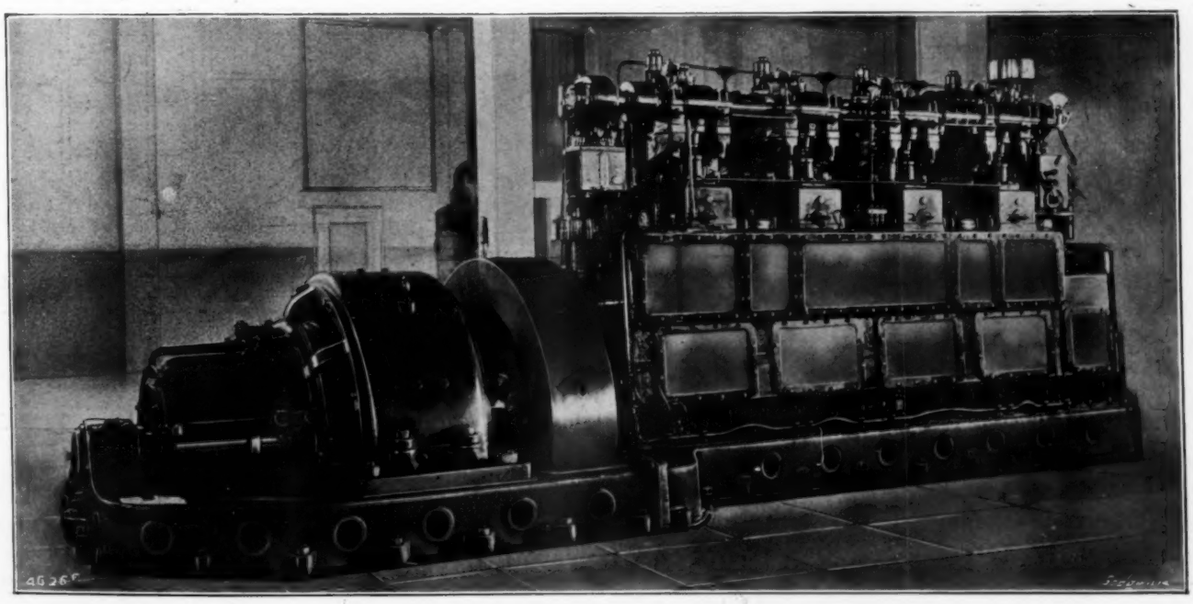


Fig. 2. Auxiliary Diesel Engine and Electric Generator for the "Ceara."

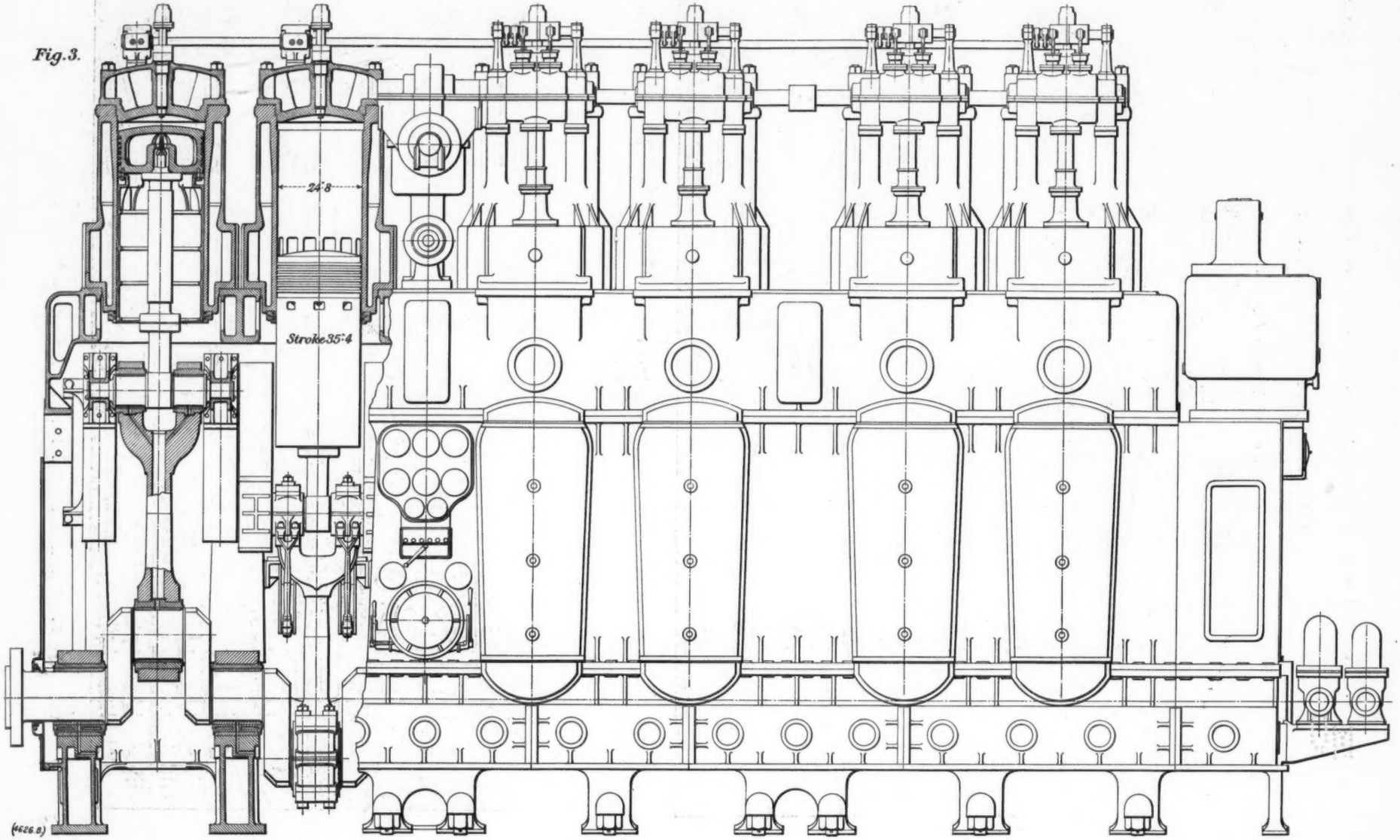
(*To Face Page* 180.)

4600-I.H.P. MARINE DIESEL ENGINES OF THE BRAZILIAN SUBMARINE DÉPÔT SHIP "CEARA."

CONSTRUCTED BY THE FIAT SAN GIORGIO COMPANY, SPEZIA, ITALY.

(*For Description, see Page* 180.)

Fig.3.



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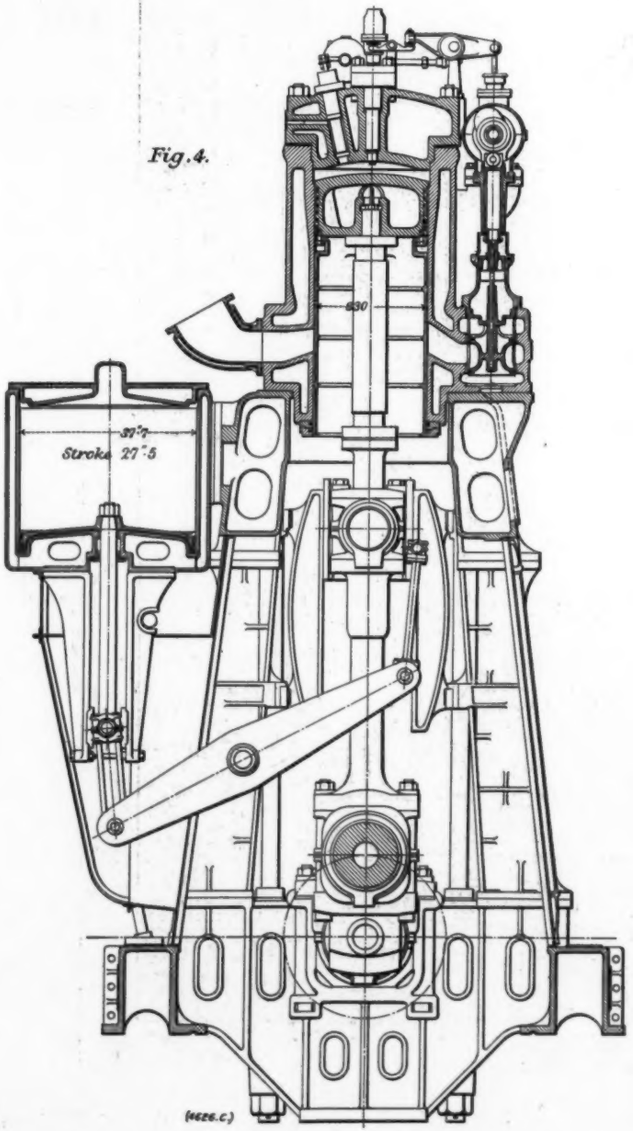
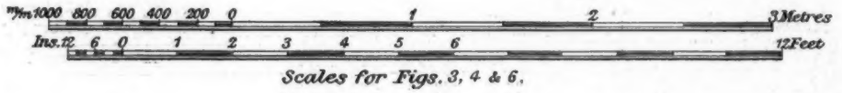


Fig. 4.



Scales for Figs. 3, 4 & 6.

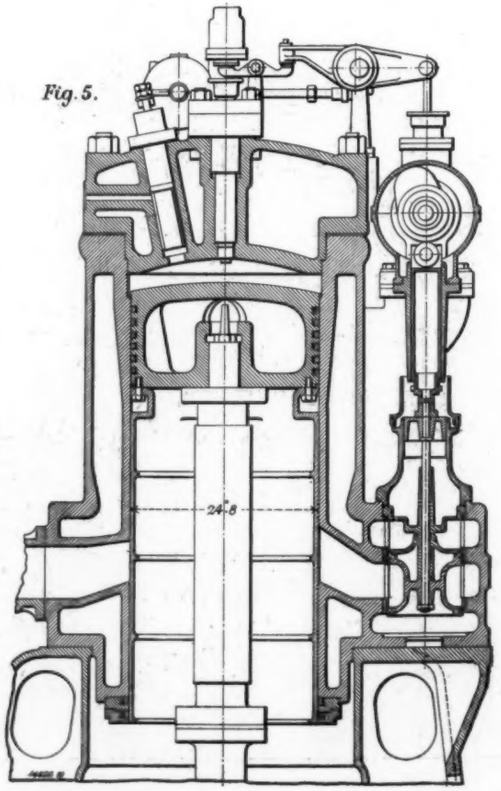


Fig. 5.

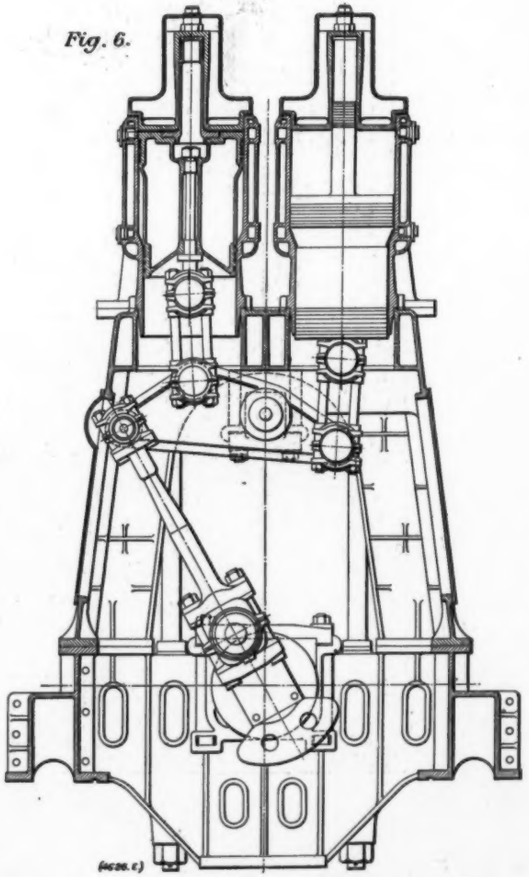


Fig. 6.

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(*For Description, see Page* 180.)

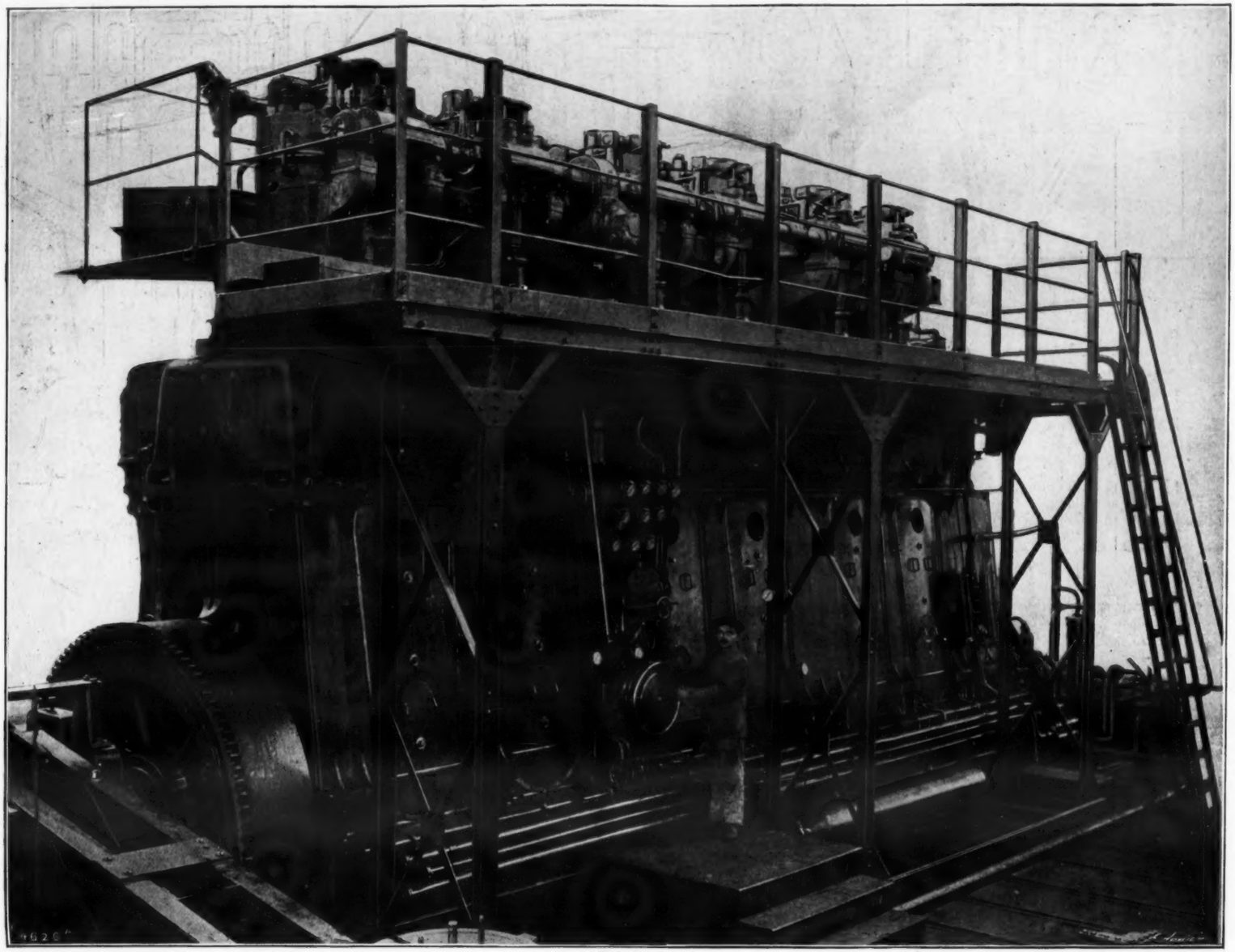

FIG. 7.

(*To Face Page* 181.)

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NOTICES OF MEETINGS.

THE ASSOCIATION OF MINING ELECTRICAL ENGINEERS: NOTTS AND DERBYSHIRE BRANCH.—Saturday, February 26, at the University College, Nottingham, at 3.30 p.m. Paper for discussion: "Static Transformers," by Mr. Chris. Jones, Member of the Warwickshire and South Staffordshire Branch.

ASSOCIATION OF SUPERVISING ELECTRICIANS.—Tuesday, February 29, at 7.15 p.m., at St. Bride's Institute, Bride-lane, E.C. Paper on "Illuminating Engineering," by Mr. Leon Gaster, F.I.J.

THE INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.—Wednesday, March 1, at 7.45 p.m. Discussion on "Suggested Applications of Science to Warfare." Opened by Mr. R. E. Dickinson B.Sc.

THE INSTITUTION OF SANITARY ENGINEERS.—Wednesday, March 1, at Caxton Hall, Westminster. "Sanitary Work at the Front with the Expeditionary Force," by Lieutenant Bernard R. Hebblethwaite, A.R.I.B.A., 2nd London Sanitary Company. Major A. J. Martin, O.C. 2/2nd London Sanitary Company (Past-President) will take the chair at 7 p.m. Discussion to follow.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Friday, March 3, at 5.30 p.m., the discourse will be delivered by Professor Silvanus P. Thompson, D.Sc., LL.D., F.R.S. The subject is "Corona and Other Forms of Electric Discharge." Afternoon lectures next week at 3 o'clock.—Tuesday, February 29. Dr. E. J. Russell, D.Sc., Director of the Rothamsted Experimental Station, Harpenden, on "The Plant and the Soil—Nature's Cycle" (Lecture I.)—Thursday, March 2. Professor L. W. King, M.A., Litt. D. F.S.A., Assistant Keeper of Egyptian and Assyrian Antiquities, British Museum, on "Recent Excavations in Mesopotamia—The Northern Capitals, Nineveh and Asshur" (Lecture I.). Saturday, March 4. Hon. John William Fortescue, M.V.O., Librarian, Windsor Castle, on "Eminent Generals of the Last Great War: Wellington's Divisional Commanders" (Lecture III.).

THE SOCIETY OF ENGINEERS (INCORPORATED).—Monday, March 6, at 5.30 p.m., at Caxton Hall, Westminster, S.W. A paper entitled "Sewage and Its Precipitation: Facts and Fallacies from Laboratory and Practical Tests," will be read by Mr. Reginald Brown, M. Inst. C.E., M.I. Mech. E., F.S.I.

ENGINEERING.

FRIDAY, FEBRUARY 25, 1916.

THE SUBORDINATION OF SCIENCE.

COMPLAINTS as to our neglect of science as a nation have long been rife, but whilst the impugnment is irrefutable, there is at least some small reason for believing that the fault lies in part with the scientific man himself. MAX O'RELL relates that, when new to our ways, he once gave a lot of private coaching to one of his pupils, who was a candidate in some competitive examination. Taking a personal interest in the youth, he did the work gratuitously, with the result that although the lad was successful, neither his parents nor himself sent a word of thanks or recognition to the zealous tutor. Profiting by this experience, MAX O'RELL on all future similar occasions resolutely "chequed" his interest in his pupils by sending in a bill on account of the special services rendered. This, he states, was always settled forthwith, the remittance being invariably accompanied by a letter of grateful acknowledgement. In short, the parents and guardians of his pupils valued his services at what appeared to them to be his own estimate.

In like fashion British scientific men, in which we include engineers, have formed a habit of rendering the nation gratuitously services of the greatest intrinsic value. In pre-war days they sat on important committees, or, before other committees, gave gratuitously professional evidence of the utmost value, the preparation of which often involved considerable outlay, which was by no means invariably reimbursed.

Since the catastrophe of eighteen months ago, men of science, pure and applied, have maintained the established precedent unaltered. For example, a well-known engineer, with special experience in chemical works, has been responsible for the design and equipment of a number of very large factories erected on behalf of the War Office. This work he has not only done gratuitously, but, finding it impossible to obtain elsewhere draughtsmen and engineers with the requisite experience, he put his own staff at the service of the authorities, thus providing them with an organisation which could otherwise have been built up only at the cost of some months' delay and much expensive weeding-out of the unsuitable or unfit. Again, Professor Carpenter, noting the demand for zinc for military purposes, and the fact that the consequent rise in price of the metal had rendered aluminium-bronze cheaper than the copper-zinc alloy, offered gratuitously to instruct firms lacking experience with this material in the best methods of overcoming the difficulties of casting it. Probably in both cases the services of these gentlemen will be valued at substantially less than if, like the lawyers, the politicians, and certain trade-unionists, they had followed MAX O'RELL's example, and "chequed" their patriotic impulses.

In fact, science, whether pure or applied, is so interesting in itself that this interest seems, *per se*, almost sufficient for many ardent minds. The trouble is that the public at large gets as a result very inadequate ideas as to the value of the services rendered.

No doubt the considerations above set forth form but a minor count in fixing the public attitude towards the scientific and engineering expert, which is unquestionably settled in the main by our unfortunate educational tradition. There is not a little reason for believing that the country would derive great benefit from an Act making it illegal for any schoolboy under sixteen years of age to devote more than one hour a week to Latin and another hour to Greek. Those whose tastes lay in classics would have ample time in the two years between sixteen and eighteen to get up to the standard necessary for aspirants to classical honours at a university, and the present enormous waste of time, in the case of the vast majority of our schoolboys, would be avoided. In fact, our schools in the past have failed to provide a general education, but have been devoted to the attempt to convert every youth into a specialist. Early specialisation is indefensible, and a much wider basis for culture should be provided than our grammarians are disposed to allow. Of course, this view will be misrepresented as an attempt to destroy classical culture. Indeed, the vested interests threatened have already taken alarm, and profess to find a sufficient explanation of Hun outrages in the wide spread of scientific knowledge in Germany. This contention, however, ignores the fact that the brutality of the German warrior has been notorious for ages, and the memory of man "runneth not to the contrary." Froissart, in discussing the respective merits of the national chivalries of his day, notes this distinguishing characteristic of the Teutonic knight, and the contemporary letters of a century ago, recently republished, recall the brutality of the Prussians in Belgium and in France after Waterloo. As a contrast, Napier quotes an official letter from Bayonne complaining that the good order kept by Wellington in his invasion of the south of France did as much harm as ten battles. All the peasants were anxious to be under his protection. In face of the historical record it is therefore somewhat late in the day to attempt to establish any connection between German laboratories and the use of civilians (women and children included) as screens for the Prussian warrior.

A second disadvantage of the inherent interest of pure and applied science is to be found in the accompanying tendency of the enthusiast to find business details relatively uninteresting. One of the leading electrical engineers, a pioneer, of international reputation, in one of its most important developments, retired from the headship of his firm two or three years ago. This firm had, under his direction, grown from employing less than a dozen hands to a pay-roll of several thousands. He gave as his reason for retiring the fact that with the lapse of every year his own work became more and more concerned with administration and finance, and less and less with technical matters. In engineering he found an interest which he could not discover in business operations. As another instance, it is reported that when one of his technical heads was offered a partnership by Mr. Carnegie, the tender was declined on the ground that business details did not interest him. The technical expert accordingly lost here an opportunity which would, in the course of a very few years, have rendered him a millionaire. Mr. Carnegie did, however, give him a very large salary in substitution for the proposed partnership.

In view of this aspect of the matter, it is, perhaps, not very surprising that the business men consulted by the Government in connection with the British Dyes, Limited, objected strongly to the presence of scientific men on the directorate of the undertaking. If, however, former experience goes for anything, this policy is likely to end disastrously. Some very instructive facts bearing on this point have recently been brought forward by Professor Armstrong, who states that the firm of Simpson, Maule and Nicholson were the leading manufacturing chemists of their day. All the partners became millionaires, and the success was due to the fact that Nicholson was a very able chemist. When he retired the firm ceased to develop. It, or its successors, still employed some very able chemists, but these had no control

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over the business policy, and the end was disaster. At one time their leading chemist was the late Professor Meldola. When he invented his blue, however, the firm refused to take it up, and he accordingly published an account of his discovery, with the result that it founded the fortunes of a leading German firm. The successor to Meldola was Professor Green, who invented in primulin a dye of an entirely new type. This the firm refused to patent, and within a few weeks it was in consequence made in Germany, the whole advantage being lost to this country. Quite comparable incidents have occurred in the history of mechanical engineering in British trade. Some 20 to 25 years ago it was by no means uncommon for the management of leading engineering firms to declare that they would not have a technical or scientific man on the premises. We can recall three instances of this, and the subsequent history of the three firms concerned, which were then in the first rank, is significant. Of the three, two have failed in the interim, and the third has not paid a dividend for years. It is in essence the same spirit which classes the drawing-office as a non-productive service. No fallacy is more fatal, and we have been much interested lately to hear the engineering director of a leading firm in the Metropolitan area attribute his success to the fact that he never employs a cheap draughtsman. Thus only was his firm able, he said, to compete successfully with low-waged districts.

In this connection it is of interest to note that the census of production showed that the value of the output per head in the various trades was, in general, the higher the greater the proportion borne by salaries to wages. Of course, such a comparison could not safely be made between two firms engaged in the same trade, as the one may pay salaries for services which a competitor puts in the wages list; but comparing trade with trade, it is noteworthy that the output per head in the "high-salaried" trades is very much greater than it is in the industries in which "staff work" is reduced to a minimum.

There is, we think, every reason for believing that in the past engineers have been rather too prone to accept the accountant's view of what constitutes a non-productive service. Mind being the principal factor in the creation of wealth, the heavy taxation to be met after the war will be raised the more easily the greater the *rôle* attributed to scientific and technical knowledge. An engineer with much experience, both with leading home and Swiss engineering firms, has observed that in an English drawing-office points would be settled in twenty minutes to which he had known three or four hours devoted in Switzerland. This rapidity has, no doubt, some very great advantages, since there is often not a particle to choose between alternative details. In other cases, however, we have known very serious consequences to follow this practice of settling important matters offhand. Many failures to realise turbine guarantees have originated directly in this practice, and we understand the same propensity was responsible for some of the earlier Diesel-engine failures. Where work is of a routine character prompt decisions are safe and advantageous, but an attempt to carry out pioneering work on the same lines is doomed to failure. The war debt will certainly not be liquidated by mere routine industry. New wealth must be created, and this can only be accomplished by striking out into new lines. If in this reliance be placed on a staff experienced merely in the past routine of the factory, the result will be far from profitable.

It is reported that some of the principal railway companies in America have a special "thinking" department under the direct control of a vice-president. This department is relieved of routine work, and is concerned solely with the improvement of the technical operation of the road. Very few of our engineering firms have a sufficiently large staff to provide for an analogous organisation. It is undoubtedly largely due to this fact that so many of them refuse to undertake pioneering work of any type whatever. An idea must be brought to them as complete in every detail as was Minerva when she sprung from the brain of Jove. In the long run this policy is as bad for them as it is for the nation. Other firms, when they take up a novelty, make the mistake of entrusting its development to what they term an "experienced" draughtsman, who, as often as not, has merely experience in the routine work of the firm, but a very inadequate knowledge of the scientific and technical principles essential to the successful development of most new ideas. One very successful firm has established the practice of invariably entrusting such pioneering work in the first instance to men with technical training, even if less experienced in shop practice than other members of their drawing-office. After complete drawings have been got out, however, the whole are submitted to the criticism of a very able and experienced mechanical engineer, who is a specialist in shop practice and foundry work. Following this a new set of designs are got out, and only after further criticism and amendment are the drawings sent into the shops.

THE MEASUREMENT OF ILLUMINATION.

To discuss intensity of illumination and, in particular, to suggest extinction methods for its determination, may appear somewhat out of place at the present time. Yet the Illuminating Engineering Society was well advised to bring up the subject of "Future Possibilities in the Design of Instruments for Measuring Illumination" at its meeting of last Tuesday. The problems of practical photometry are well understood now, after long neglect, and handy and inexpensive instruments are at everybody's disposal. But with increasing knowledge have come increasing demands on the reliability of the instruments, and it must be acknowledged that, when it comes to the legal interpretation of what is adequate illumination in workshops, school-rooms, and thoroughfares, within the regulations or within the contract specifications, actual instruments are found deficient in accuracy and reliability.

When illuminating engineers are endeavouring to find improvements, the important question at once arises: are we to rely on physiological or on physical and chemical methods? In so far as the illumination is to supply light for the eye, the question may appear superfluous, apart from the economical aspect of the matter. The various sources of light differ very much in efficiency; with that we have nothing to do at present. But the different methods and instruments have different sensibilities both for the same and for different sources of light, all differing vastly from the human eye. Surprisingly good work is done by eye comparison, in spite of colour differences and other difficulties; yet physical or chemical instruments should furnish us with a much more reliable and exact basis for quantitative light-intensity determinations. To indicate the general scope of the problem and of the discussion, the Illuminating Engineering Society had submitted five main questions to its members. A good many suggestive replies had been received, which Mr. J. S. Dow ably summed up, and the oral discussion following will call forth further communications, which may clear the way to a better understanding.

The first question asked for suggestions to make the ordinary type of illumination photometer—*i.e.*, instruments involving the use of a comparison source of light—more convenient for the use of the general public. Mr. Trotter deprecated studying the general convenience too much in this respect. When a comparison source of light, mostly a glow-lamp, is used, a battery is required, and the intensity of the comparison lamp depends upon the battery current. Corrections have to be made for current variations, and Dr. Marchant proposed to furnish a correction table, together with the photometer. That would not quite get over the difficulty, unless the portable photometer be converted into a kind of portable laboratory, though we agree with Mr. A. Cunnington, jun., that a portable instrument, frequently checked in the laboratory, is preferable to a portable laboratory. Special photometers for special purposes can certainly be made very handy. Mr. Cunnington showed an extension holder for the screen, whose illumination is observed; the screen has otherwise to be put on a tripod. He also showed a very simple box containing one or two lamps, the light from which fell through a number of diaphragms of different diameters on the top plate (of ground glass or greased paper) of the box, giving eight light spots of different intensities; the plate itself, illuminated by the light to be tested, would appear brighter than some spots and darker than others, and thus a fair estimate could quickly be made. Mr. W. Cunnington, sen., had, he said, tried to produce a screen which would appear equally bright all over up to the edge, even under magnification; cardboard and celluloid were not satisfactory, but he had found that flashed glass (opalised on the upper surface) would answer. When the light of the comparison lamp fell on such a plate, about $\frac{1}{4}$ in. thick, at 45 deg., the whole thickness of the glass was uniformly illuminated; and when a diaphragm was placed in front of the plate, a bright half disc, limited above by the upper edge of the plate, was seen. With the aid of several such glasses, whose distance apart could be adjusted, and small lamps (much less than one candle), he had constructed several small portable photometers (one of the size of a finger) which were distinguished by great range; small current fluctuations would, we are afraid, however, much affect the brightness of these small lamps.

Question two concerned extinction instruments, in which the illumination is diminished until some small object becomes invisible or fine type illegible. Of these instruments nobody had much good to say, though Mr. Walsh mentioned that they had tried various light-filters (glass), as well as lines, $\frac{1}{4}$ mm. apart, scratched on blackened glass (a kind of very coarse grating), and several layers of loose fabric in testing coloured lights at the National Physical Laboratory.

Question three concerned various physical or chemical instruments, selenium cells in the first instance. Mr. Addenbrooke was afraid that the diminution of the resistance of the illuminated selenium cell depended on the impurities present in the selenium. Mr. W. R. Cooper and Mr. Gaster, on the contrary, considered that pure selenium was most suitable, and that it could now be obtained; but they agreed that much depends upon the preparation and maintenance of the cell, that the researches are not sufficiently advanced, and that selenium cells are not suitable for continuous work. They have a time-lag, moreover, and are not sensitive to the same rays as the eye. Yet Mr. C. T. Turner and others have constructed minimum photometers in which an electromagnet is so connected with the selenium cell that a bell rings when the illumination, falling on the cell, is insufficient, and such instruments have their utility. Photo-electric instruments, Mr. Walsh pointed out, had been worked out in Germany, and had within the last year been studied in America, chiefly by Dr. H. E. Ives, who had sent a communication to the meeting, and others. These cells depended upon the ionisation produced by light in bulbs containing a cathode of an alkali metal within an atmosphere of some inert gas. It had been found that the cells should be prepared by passing a glow discharge through the bulb filled with hydrogen; a hydrogen hydride seemed then to be formed, which was much more sensitive than the metal itself; but this sensitiveness fell off unless the hydrogen was subsequently replaced by argon or helium. If no gas were present, the photo-electric currents would be altogether too weak; as it was, the feeble intensity of the currents was the drawback of the method. Richtmyer had recently described (in the *Physical Review*) photometers, consisting of a Wheatstone bridge arrangement comprising two photo-electric cells. According to Richtmyer the current was really proportional to the illumination, whilst Ives questioned that proportionality—which would be another disadvantage of the method.

Like the photo-electric photometers, the thermopiles are so far only laboratory apparatus, but they have a future. Suggestions for the construction of suitable thermopiles were made by Dr. Ives and also by Dr. C. Féry, of Paris, who uses copper acetate solution for absorbing the heat rays of the light.

Photographic methods relying on the darkening of paper, sensitised or not by means of erythowin, ethyl red, pinachrome, dicyanin, &c., are all open to the objection that, in spite of the sensitisers, the actinic rays are not the rays which give the visible light. For comparative measurements of arc-light fluctuations simple photographic apparatus are appropriate, of course, and they find application in meteorological instruments, on which Mr. F. J. Whipple, of the Meteorological Office, spoke. There Abbot's silver pyrheliometer and Callendar's radiation recorder and other instruments of the bolometer type are made use of. The idea of the bolometer is that the energy of the radiations is absorbed by one blackened coil of platinum, whilst another, equal bright coil reflects the light, and that the heat absorbed by the first coil is balanced by a current sent through the second coil; thus absolute measurements become possible. But for practical photometry all such instruments would be too

expensive. In a simple form of apparatus the difference in expansion of two metallic elements—one polished, the other coated with an absorbent material—is utilised for light and heat regulation purposes.

We should have stated that the fourth question referred to instruments of the meteorological kind, and the fifth to minimum instruments, which gave warning when the illumination in an interior has fallen below a prescribed minimum. The meeting thus discussed, under the presidency of Mr. W. Goodenough, a great variety of instruments. The subject is still in the experimental stage; but there is little doubt that physical method will ultimately prevail over the eye-test. The astronomers have acquired very useful knowledge by using both eye-photometers and photographic and other methods in estimating stellar magnitudes. In practical illumination the source of light is not inaccessible, as in the case of the stars. But the application of different methods, best adapted to different purposes, will prove useful in practical photometry as well, and it is time to attack the problem from various points.

THE BRITISH INDUSTRIES FAIR.

On Monday last the second British Industries Fair was opened at the Victoria and Albert Museum, South Kensington, London, S.W., and it will remain open until Friday next, the 3rd prox. It will be remembered that the object of these fairs is to bring British manufacturers into contact with buyers for the home and overseas markets, and thus assist the former to capture the trade in certain products previously supplied by Germany. The first fair was held last spring, at the Royal Agricultural Hall, Islington, and the results were so satisfactory that the Board of Trade, which was responsible for the organisation, was urged by the exhibitors to take control of any future fair of a similar character that might be held. It has since been decided to continue holding these fairs annually, and it is hoped that they will have an effect on British industries similar to that of the Leipzig Fair on German industries. Only British manufacturing firms are permitted to exhibit, and the goods shown must be of the exhibitor's own manufacture. The trades represented are those in which German competition has been most severely felt in the past—viz., toys and games; earthenware, porcelain and china; glass and glassware; fancy goods; and stationery and printing. A most casual glance round the exhibits will suffice to show that British manufacturers are capable of producing goods superior in every way to those of German manufacture, and this favourable impression will be considerably strengthened by a closer inspection. When it is remembered that most of the firms are short of labour, and many of them are engaged on war work of some kind or other, the display is all the more creditable, and there can be no possible doubt that all requirements of the home and colonial markets, in the trades represented, could be met by British manufacturers. The general opinion of the exhibitors is, however, that in order to retain these markets some form of protective tariff will be essential, as it is known that goods are now being made and stocked in Germany to flood the markets after the war. Manufacturers are naturally loth to embark on new lines involving heavy expenditure for designs, moulds, works extension, &c., for markets which may be transitory, and it therefore seems highly desirable that a definite policy should be stated as soon as possible. In view of the splendid display in the fancy goods and stationery and printing trades, it also seems most regrettable that the supply of paper should be restricted, as those trades, and others dependent on them, cannot fail to suffer from a shortage of this most essential material. In all such considerations precedence must, of course, be given to the speedy and successful termination of the war, but at the same time trade, and particularly export trade, was never more important than at the present time.

There is but little of direct professional interest to engineers in the Exhibition; indirectly they will, of course, be affected by the results obtained, as will all other members of the community. The most interesting exhibits, from a technical point of view, are to be found in the section devoted to the glass and glassware trades, in which several firms are now manufacturing goods previously supplied almost entirely from Germany and Austria. The Edinburgh and Leith Flint-Glass Company, of Norton Park, Edinburgh, for instance, are now manufacturing a number of special glasses to formulæ supplied by the Institute of Chemistry. Among them is included a glass for Röntgen-ray bulbs and tubing. This is a soft soda-glass which gives the characteristic green fluorescence under the cathode discharge, and works admirably in the blow-pipe flame, with no tendency to devitrify or discolour by repeated heatings. It is claimed to be non-hygroscopic, and tubes made from it give no indications of surface conductivity; bulbs can be supplied in four sizes—viz., 125 mm., 150 mm., 175 mm., and 200 mm. in diameter. This firm also exhibit specimens of a lead-glass of very high density, intended to protect workers from the effects of Röntgen rays, to which it is practically opaque; it is made in the form of sheets or covers for tubes. A special enamel-glass, for sealing platinum wires into vessels made from soda-glass, is also shown. This glass, it is stated, joins perfectly with soda-glass, and forms a tight joint with platinum, so that there is no tendency to crack, even when the joint is cooled relatively rapidly. A similar glass for making joints with iron, and made for the first time as recently as last week, is also exhibited; a glass for joining copper is now being made, but is not yet on view. Other products of the firm include coloured-glass rods; opal glass for tubing, rods, &c.; glass for electric-light bulbs, tubing, and rods; glass for miniature electric lamps; and glass for artificial human eyes. We imagine that it will surprise some of our readers to learn that glass for the last-mentioned purpose must be of a special quality to avoid corrosion. Messrs. John Moncrieff, Limited, of Perth, the well-known manufacturers of gauge-glasses, are now manufacturing flasks, beakers, and other laboratory apparatus of a glass similar to Jena glass. A fine selection of these vessels is exhibited as well as lubricator glasses, miners' lamp-glasses, electrical glassware, hard combustion tubing, soft soda tubing, &c. Examples of their "Unific" and "super-glass" gauge-glasses, and glass blocks for "Klinger" water-gauges, are also shown. Messrs Burtles, Tate and Co., of Poland-street, Manchester, who have recently taken up the manufacture of glassware for medical and surgical purposes, and also for all kinds of lighting, show several examples of these products, in addition to their ordinary lines of table-glass, &c. Other exhibits which should be mentioned in this section are those of "Glass Sundries," of 25 and 26, Brook-street, London, E., who show gauge-glasses and protectors, electrical globes and reflectors, watch-glasses and scale-pans for chemical work, lamp-glasses, &c. Messrs. A. M. Allan and Co., of Firhill, Glasgow, are showing glass pavement-lights and deck-lights of several patterns; Messrs. Greener and Co., of Sunderland, exhibit samples of lenses for electric torches and railway lamps, as well as deck-lights and pavement-lights; machine and hand-made bottles are shown at the stand of Messrs. Connolly and Steele, of Pendleton; Messrs. Molineaux, Webb and Co., Limited, of Ancoats, Manchester, who are manufacturers of dioptric lenses for ships' lanterns, railway lamp-glasses, globes and shades for electric lighting, and other technical glassware, show a selection of their products; and Rust's Vitreous Mosaic Company, of Battersea, London, S.W., show their vitreous tiles and mosaics for walls, floors, and ceilings. We understand that the tiles are made principally from waste plate-glass, with which silver-sand and other ingredients are incorporated, so as to form a hard, non-slipping tile, of a very attractive appearance. The tiles can be supplied in practically all colours and sizes, so that most artistic effects are obtainable with them.

Few of the exhibits in other sections call for comment from us, but we may mention the Brownlow filter, at the stand of Messrs. Slack and Brownlow, of Gorton, Manchester. These filters, although not a new product, are intended to compete with similar appliances of German and Austrian origin, and are made in numerous types and sizes for domestic and industrial use, as well as in portable forms for travellers. The filtering elements consist of cylinders of porous porcelain, which is claimed to be rapid in action and to ensure an absolutely sterile filtrate. The cylinders are designed so as to be easily removable for cleaning and occasional sterilisation. Messrs. F. Darton and Co., of Clerkenwell, London, E.C., show a number of small dynamos, suitable for car-lighting and accumulator-charging, as well as a selection of their other products, which include accumulators, thermometers for all purposes, hydrometers, hygrometers, and other meteorological instruments. Metal name-plates and labels suitable for machinery and instruments are exhibited by the Endolithic Manufacturing Company, Limited, of 61½, Fore-street, London, E.C., who also make them in ivory, imitation ivory, and bone. The "Imperial" typewriter, at the stand of the Imperial Typewriter Company, Limited, of Leicester, is also worthy of inspection. The most noticeable feature of this machine, which has been on the market about seven years, is the very small number of working parts, and this feature enables it to be sold at about half the price of the standard machines. There are only two levers to each key—viz, the key lever and the type bar, and these are merely fitted together so that the former operates the latter without any connecting link or other direct attachment. The escapement, for feeding the paper, is operated by a bar which is depressed by an extension from the key-lever when the key is pressed down. The machine is of good appearance and is claimed to be durable and capable of very rapid work, both of which claims seem reasonable from the nature of the mechanism. Another interesting feature of the machine is that the whole set of keys and type-bars can be removed together, and another set substituted in a few seconds for writing in a different language, or with another style of type.

Admission to the Fair is by invitation of the Board of Trade only, and the invitations are confined to *bond-fide* buyers for home and overseas markets. It is, in some respects, regrettable that the public cannot be admitted for some part of the time, as an inspection of the goods displayed would do much to dispel the impression that British manufacturers are behind the times. We should also like to see the chemical, electrical, and engineering trades properly represented, though at the present time manufacturers in these industries are too fully occupied with Government work to be seeking for other business. It may be useful to mention here some of the other special steps taken by the Board of Trade, since the outbreak of war, to assist British manufacturers to capture the trade of enemy countries. This work has included the collection of some 6000 samples of German and Austrian goods, representing about 70 different trades and industries, from 66 overseas markets, and the exhibition of these samples in various large industrial centres. The Board also issues memoranda giving information regarding possible developments in certain trades, and issues lists of articles in respect of which inquiries have been received for the names of manufacturers or buyers. A collection of over 3000 German and Austrian trade catalogues has also been made, and is available for inspection at Wakefield House, 32, Cheapside, London, E.C. An index of the catalogues can be obtained, and, in certain cases, catalogues will be lent out to provincial firms. It is to be hoped that British manufacturers and merchants will avail themselves of these facilities to the fullest possible extent.

CANALS AND THE COST OF CARRIAGE PROBLEM.

The Lord Mayor of Birmingham, Alderman Neville Chamberlain, presiding over a meeting of the Business Club on Friday, the 18th inst., assembled to hear a lecture on canal development by Mr. Frank Impey, secretary of the Waterways Association, said that since the war began we had seen the railways of the country absolutely congested, and totally inadequate to carry all the material required. If only we had had the improved waterways the association had been advocating we should have avoided, to a considerable extent, the difficulties experienced. Mr. Impey, in the course of his lecture, suggested that water would be the solvent of the transport problem. The journey from Hull to Nottingham now occupied 57 hours, but when the powers obtained by the Nottingham Corporation were exercised the time would be reduced to 31 hours. From Bristol to Birmingham the time now occupied was 72 hours, with transhipment in the middle, and four systems of haulage were employed. In the new scheme proposed the time would be reduced to 36 hours, with no transhipment. The express boats now working between London and Birmingham employed one man to every 7 tons of cargo. With the improved canal and the

larger barges proposed each hand would be responsible for 35 tons. There would be a saving of fuel of 50 per cent. The Waterways Association advocated the combination of efforts between the State and the local authorities, as in Continental countries. Mr. G. Shipway believed that canal development would provide a magnificent public work for returning soldiers to be employed upon until such time as the industry of the country got into working order again. Mr. Wilfrid Hill, we are glad to observe, insisted that in their zeal for waterway development they must not overlook the yet undeveloped possibilities of the railways.

As this question of canal development is now being again strenuously agitated, it will not be inopportune to subject it to a little practical criticism. The object in view is to provide us with an efficient inland waterway system, such as exists in certain Continental countries. An expenditure of some 20 odd millions is suggested for the widening, deepening, and extending of our canal system, in order to provide for barges of 100 tons capacity, over some 4000 or 5000 miles of inland navigation. Would such expenditure be justified? It is quite true that they have splendid inland waterways on the Continent—7000 miles in Germany and a similar mileage in France—and that fine barges of 150 tons, and even 300 tons, capacity carry goods at an extremely low cost and at a very good speed, and it is assumed that what is done in those countries can be done here. But our canal advocates do not pay sufficient attention to the physical differences between this country and those parts of the Continent which are so well served by canals. In Germany, France, Belgium, and Austria the chief industrial districts served by inland waterways are comparatively flat, and possess fine rivers naturally adapted to canalisation, whereas all the way from Scotland to the Peak of Derbyshire we have the Pennine Chain. In industrial Scotland, Durham, West Yorkshire, and South Wales there is hardly a bit of level country or a river naturally suitable for navigation. Even in the short distance between Birmingham and Worcester there are fifty-eight locks. There is a drop of no less than 425 ft. between the capital of the Midlands and the Severn. In England and Wales, for only 3800 miles of navigable inland waterways, we have no fewer than 2377 locks, and we have scores of tunnels, forty-five of which are over 100 yards long, sixteen of them varying from 1000 yards up to as much as 3808 yards in length, seven of them being over 3000 yards long. If, under the scheme proposed by the Waterways Association, the locks can be reduced by two-thirds, the number, relatively to the length of navigation, will still be abnormal, involving many delays, compared with what is experienced on the Continent, while the cost of reconstructing our canal system would be enormous. The capital cost would far exceed anything expended on foreign canal systems. From this it follows that our scheme would either have to be run at a loss or the barges would have to pay such dues as would render the cheap transit aimed at impossible. While Nature has enabled us to be a first-class external shipping country, it has handicapped us in relation to inland water carriage.

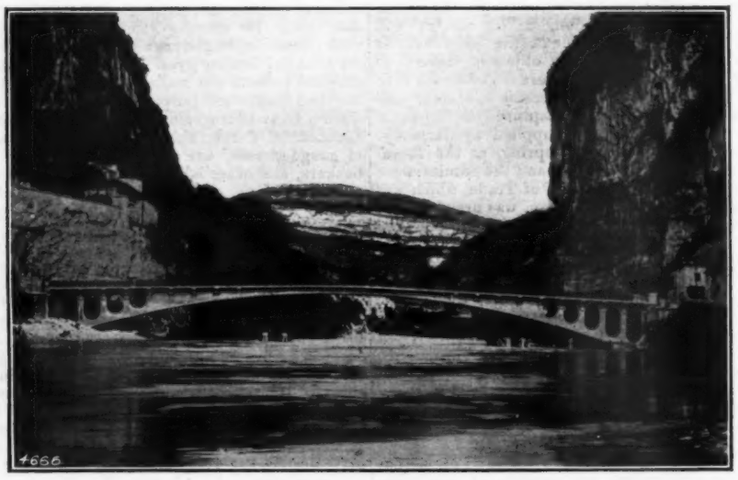
The vast difference between the natural conditions—in other words, the engineering problems—in Britain and those of the industrial parts of Europe may be gathered from the fact that whereas of our navigable inland waterways in Great Britain of 4075 miles, only 1482 miles are natural river, in France 4392 miles are natural out of 7006; in Germany, 5815 miles are natural out of 7038; in Austria, 2427 miles are natural out of 2772; and in Russia, 23,211 miles are natural out of 23,614. Our lack of level country and our shortage of big natural rivers, the necessity for nearly the whole of our inland waterways to be artificial, and the abnormal number of locks needed, involving constant pumping of water up to the top levels, are conditions that combine to make economical canalisation a physical impossibility in this country. Our only really efficient barge canal system is that of the Aire and Calder Navigation, and it owes its success mainly to the existence of tide water from Hull to Goole, and to an unusually level bit of country between Goole and Castleford. It is quite true that the canal connecting the Maine with the Rhine has 177 locks in 193 miles, and the southern section of the Canal de Z'Est has 99 locks in 91 miles; but those are exceptions on the Continent, whereas such conditions are general in this country. For instance, there are only three locks between Berlin and Hamburg, a distance of 230 miles. Between London and Liverpool we have more than 200 locks for less than 300 miles of canal. Some of our canals are capable of improvement, but the physical features of our country are such that the cheap and speedy canal transit obtaining on the Continent is not possible with us, and that it is to an improvement and general development of the railways that we must look for a solution of our cost-of-transit problem.

OPTICAL STRESS ANALYSIS.

In past years it was not uncommon to use sheets of lead to distribute heavy pressures over masonry, and many of the early experimenters, in making compressive tests of blocks of stone, interposed similar sheets between the faces of the stone and the platens of the machine. It was soon recognised, however, that under these conditions failure occurred sooner than when the lead was omitted. Moreover, as was first pointed out by Dr. Unwin, the character of the fracture was also different. When embedded on sheet lead, the stone was inclined to split into vertical laminæ as if it had been subjected to a bursting force, whilst a similar block, in which the pressure was applied through a less plastic packing, broke up along the planes of shear into a series of pyramids.

In an interesting lecture delivered at the Royal Institution last Friday, Professor E. G. Coker—whose investigations of stresses by optical means we have dealt with on several former occasions—described some recent experiments carried out in conjunction with Professor Filon, in which polarised light is employed to map out the character of the stress in a specimen of xylonite subjected to simple compression. These experiments showed very clearly the important part played on the character of the stress by the surfaces in contact. When the pressure was transmitted to the xylonite through hard steel faces, the analysis made by polarised light showed very clearly that the stress was far from uniform for some distance from the pressure faces. The steel prevented the natural lateral expansion of the celluloid, and the distribution of the stress was modified accordingly. On substituting india-rubber, a converse action was apparent; the rubber as it swelled under its load appeared to exert a bursting stress on the specimen. The only arrangement found to give an approximately uniform distribution of the stress was to use thick packings of the same material as that under test.

Some investigations into the distribution of stress on the head of an eye-bar were also described by the lecturer. Many experiments have previously been made on the most economical form of eye-bar head by the process of testing bars to destruction and cutting away metal where the results showed it to be superfluous. The names best known in this connection are those of Sir Charles Fox and Mr. Berkley in this country, and that of Mr. Shaler Smith in America. An account of the experiments made by the latter will be found in our issue of November 30, 1877. All these tests concurred in showing that the depth of metal between the eye and the end of the bar should be much greater than at the sides. In all experiments made by testing to destruction the elastic limit is necessarily exceeded, and it is therefore very interesting to note that the results obtained in this way are substantially confirmed by Professor Coker's experiments with polarised light, which reveal the distribution of stress within the elastic limit of the material. The results, as set forth in his lecture, show great inequalities of stress distribution at the sides and end of the eye. These inequalities are very much greater in the case of circular heads than with heads of the form arrived at by the experimenters already named, and a still better distribution is obtained by easing the curves of transition between the body of the bar and the head rather more than was suggested by Mr. Berkley. It is not, however, possible with any form of head of constant thickness to get a uniform distribution of stress across the metal at the sides of the eye. The stress is always materially greater next the hole than at the outer edges of the head. In fact, with heads of circular outline, the metal at the outer edges may be actually in compression, whilst the tension in the metal adjoining the hole rises to nearly three times the average value. In spite of this, however, it has been usual during recent years in American bridge practice to adopt circular heads, as fewer dies will then serve than would be required with a more rational form of head. The diameter is, however, made so large that under test the eye-bar always fails in the body, and not in the head.



Reinforced-Concrete Bridge over the Rhone at La Balme; Designed by M. Mesnager, Paris.

One of the most interesting exhibits made by Professor Coker was the illustration, which we reproduce herewith, of an arch bridge of 310 ft. span, designed by M. Mesnager, of Paris. The stresses in this structure were determined by making a model in glass and analysing by means of polarised light the stresses in this model under various loadings. The material used for the bridge is reinforced concrete. The design is, it will be seen, of great boldness, harmonising well with the character of the surrounding scenery.

NOTES.

The Baghdad Railway.

The work on the Baghdad Railway has now, it appears, arrived at a provisional conclusion. In the direction from Aleppo to Baghdad, both the sections Aleppo-Moslemie-Ras-el-Ain—about 300 kilometres—and the section Samaria-Baghdad—about 142 kilometres—have been completely constructed and are in full working operation; but between them the intermediate section—Ras-el-Ain-Mossul-Samaria—is still missing, a distance of 591 kilometres, the construction of which, however, on account of the difficulty of obtaining the different materials, cannot be proceeded with until after the termination of the war. In the direction from Aleppo towards Konia (and Constantinople)

there still remain to be constructed the two tunnel sections through the Ancanus (from Islahie to Mámure, 54 kilometres) and through the Taurus (from Dorak to Kara Pounar, 52 kilometres). Of the former section, the Baghtsche tunnel (5 kilometres) has already been pierced for several months, and the work has been so energetically proceeded with that the section Islahie-Mamure can now be opened on a small scale, and fully on October 1, 1916. Then the only missing link in the railway connection between the Syrian Railway system and Constantinople will be the Taurus section, where a series of tunnels, of an aggregate length of 11½ km., have to be constructed, which will probably take another year or two. In the meantime this missing section can be crossed by a high road, constructed purposely. The aggregate length of the line Haidarpasha (Constantinople) Konia-Baghdad, of which the section from Haidarpasha to Konia belongs to the (German) Anatolian Railway Company, whilst the section Konia-Baghdad represents the Baghdad Railway proper, amounts to 2435 km., comprising the following sections :—

	Km.
Haidarpasha-Eski-Schehir	313
Eski-Schehir-Afian-Karahissar ...	162
Afian Karahissar-Konia	262
Konia-Kara Pounar	293
Kara Pounar-Adana	77
Adana-Islahie	153
Islahie-Aleppo	142
(Aleppo) Moslimie-Mossul	633
Mossul-Baghdad	400

Of this aggregate length 1748 km. are now open to traffic, and after the opening of the Ancanus, the aggregate distance open to traffic will be 1802 km.

Reinforced Concrete for Water Supply Services.

In a paper recently read before the Concrete Institute, Mr. C. F. Marsh, M. Inst. C.E., of the London Water Board, gave some useful notes on the use of reinforced concrete in water works. For work of this class Mr. Marsh said that the concrete should be richer in cement than usual. For reservoirs, tanks, and dams, a mixture of 810 lb. of cement to 13½ cub. ft. of sand and 27 cub.ft. of broken stone or shingle was sufficiently water-tight for all but the highest heads ; but for pipes and other thin-walled structures a mortar consisting of 1620 lb. of cement to 27 cub. ft. of sand should be used. In fact, in walls of 3 in. or less there was, he said, a danger in the use of broken stone or shingle, since two pieces might conceivably come together and leave a plane of leakage. Where the use of broken stone was permissible it should be sufficiently small to pass a ¾-in. square-meshed sieve, and it might with advantage be even smaller. It was not, he said, advisable to use richer mixtures than the foregoing, since a rich mixture shrank more on drying and expanded more when wet, thus increasing the liability to cracks. The imperviousness of concrete could be increased by the addition of hydrated lime, which was, Mr. Marsh said, quite as effective as any of the patented compounds in the market. After moulding, the concrete should be kept damp for a period of about four weeks. In the case of long structures, exposed to variations of temperature, or alternately wet and dry, it was, he said, advisable to provide contraction-joints at intervals of about 30 ft. Leakage at these joints was prevented by sheet-lead or copper baffles extending well into the concrete on each side of the joint. Dams when built of reinforced concrete were generally hollow, the up-stream face consisting of a slab built at a slope not steeper than 1 to 1, and the down-stream slope was somewhat steeper. With a dam of this kind the resultant pressure did not range far from the centre of the base whether the reservoir was full or empty. The base-plate of the dam was perforated, so that any percolation below it escaped down stream. Dams of this type had been built as high as 108 ft., and were very much lighter than solid concrete structures. Reinforced concrete had also been largely used for elevated water-towers, being 40 to 50 per cent. cheaper than tanks of steel plates, and much more sightly. In using reinforced concrete for pipes, it was not necessary to embed in it any special impervious layer unless the head exceeded 40 ft. With higher heads, however, the "Bonna" system was useful. In this case a thin acetylene-welded steel pipe was embedded in the concrete, which was reinforced externally only in the case of small heads, and both internally and externally for higher pressures.

MESSRS. PETTERS, LIMITED, YEOVIL.

On Tuesday last, Messrs. Petters, Limited, of Yeovil, had on view a "semi-Diesel" engine of 300 brake horse-power which they have just completed for a South American electric power-station. The engine is capable of operating with any mineral oil of not more than 0.92 specific gravity. It has four cylinders, 16 in. in diameter by 18 in. stroke, and is designed to run at 250 revolutions per minute, but the governor is provided with a "speeder" gear, by which this speed can be adjusted as the demand for current varies. With this type of engine there is, as is well known, an impulse every revolution. The piston in its descent compresses air previously drawn into the crank-case through a suction-valve, and as it nears the end of its down-stroke first uncovers the exhaust-port, so that the pressure inside the cylinder is reduced to that of the atmosphere. This exhaust-port commences to open when the piston is still 3½ in. from the end of its travel, and when it has moved another 1½ in. a second port is uncovered. This port establishes a communication between the crank-chamber and the interior of the cylinder ; through this the charge of air, previously compressed in the crank-chamber to about 5 lb. above the pressure of the atmosphere, enters the cylinder, driving out the remainder of the spent gases, a deflector on the piston preventing any short-circuiting of the incoming air direct to the exhaust-port. On the return stroke the air which has thus entered the cylinder is compressed, the clearance being such that at the end of the stroke the pressure inside the cylinder is about 150 lb. A jet of oil is then squirted into the cylinder through an orifice about $\frac{1}{16}$ in. in diameter, and this oil is ignited by the red-hot wall of the cylinder-cover, which to this end is not provided with a water jacket. The pressure, in consequence of the ensuing combustion rises to about 280 lb. to 300 lb. per sq. in., and the out-stroke commences. At full load the oil consumption is stated to amount to 0.47 pint per brake-horse-power hour, a figure which rises to about 0.65 pint at half load.

The engine is governed by varying the amount of fuel injected per stroke. Each cylinder has an independent fuel-pump. The stroke of the plungers of these pumps is diminished as the load on the engine falls. This is effected by driving them all from a shifting eccentric, controlled by a shaft-governor. Very good regulation is obtained, the speed varying very little between full load and no load. Forced-feed lubrication is provided for the cylinders and both ends of the connecting-rods, whilst the main bearings have oil-well lubrication. Since the crank-chamber is used as the pump for the scavenging air, provision is necessary to prevent loss of oil through the end bearings of the crank-shaft. This is effected by means of a gun-metal ring keyed on the shaft, but free to slide axially. This ring is scraped true with a facing strip at the inner side of each end bearing, and a U leather held down by a spring makes good the joint between the ring and the adjoining crank-cheek. The engine is started by air, special valves being fitted to this end to two of the cylinders; but in practice it is found that compressed air need be admitted to but one of these cylinders and for one stroke only. To start the engine, all the cylinders are heated by blow-lamps. When sufficiently heated, an operation which requires 10 to 15 minutes, compressed air is admitted to the one cylinder for a single stroke. The other cylinders then take in their fuel charge, and normal running ensues.

Messrs. Petters it may be noted, built their first engine in 1895. This was of 3½ horse-power, and was fitted to a motor-car. A demand for small oil-engines becoming apparent, the manufacture was continued, and in 1901 a small company was formed to extend the business, about 50 to 60 men being then employed. In 1910 it became evident that large extensions must be made, and an area of 65 acres was secured on the outskirts of the town. Of this area, 20 acres were reserved for the shops, and the remainder laid out for the erection of a model village for housing the employees of the firm. Only four of these cottages had, however, been built when the Kaiser decided that the time was ripe for his long-meditated assault on the liberties of Europe, and it will be impossible to proceed further with the scheme until the end of the war. Some of the new shops had, however, been completed, and are now busily engaged, since, in spite of 200 men having joined the Forces, nearly 1000 are still employed, together with a certain number of women. The engines built to date number 11,702, with an aggregate capacity of 109,609 horse-power.

It had been the intention of Messrs. Petters to reserve their original shops for the manufacture on a large scale of small two-cycle paraffin-engines. These engines have cylinders 4½ in. in diameter, and at 600 revolutions per minute generate about 5 horse-power. They are fitted with magneto ignition, and are designed to be started on petrol, but to do their work on paraffin. The base of the engine serves as a fuel-tank. The engines have proved very suitable for the driving of portable electric-lighting sets, as well as for many other purposes. The plant was laid out for an output of fifty per week.

All the castings are machine-moulded, and all the flanges on the engine standards are finished from the rough by a surface-grinder. The cylinders are bored in a special machine having four boring-heads, of which three may be in operation whilst work is being removed and replaced at the other. All the holes necessary for fixing covers and the like are drilled by a duplex multiple drilling-machine, each head of which has six spindles. Thus whilst the six holes are being drilled on the head of one cylinder another cylinder is being made ready under the other head. All working surfaces are finished by grinding, thus ensuring extreme accuracy of form.

THE LATE PROFESSOR ROBERT HENRY SMITH.

We regret to have to announce the death, which occurred suddenly at his residence, Streatham, on Friday last, the 18th inst., of Professor Robert Henry Smith, M.A. Professor R. H. Smith was a Whitworth Scholar, a Member of the Institution of Mechanical Engineers, an Associate Member of the Institution of Civil Engineers, and Emeritus Professor at Birmingham University. He was the second son of the late Mr. William Smith, LL.D., and was born in 1852, in Edinburgh, where he received his primary education, his scientific and technical training having been acquired at the Edinburgh University.

On leaving the University, Professor Smith served a term of apprenticeship with Messrs. Tennant and Co., Leith. He was subsequently employed for a term in the works of Sir Joseph Whitworth and Co. and in the drawing-office of Messrs. Wohlers, Berlin. In later years he was appointed professor of civil and mechanical engineering at the Imperial University, Tokio, and afterwards as professor of civil, mechanical, and electrical engineering at Mason College, Birmingham.

In the course of his career, Professor Smith has written a very large number of articles on engineering subjects for the technical Press, including, among others, reports upon the technical features of Continental exhibitions. He is also the author of numerous books on commercial economy in steam, heat and power plants, on electric traction, also of treatises on hand and machine-tools, on the calculus for engineers; he has also compiled diagrams for the conversion of British and metric measures, arithmetic tables for the calculation of premiums on wages, &c.

We may state, as a painful coincidence, that his sister, Miss M. L. Smith, the elder surviving daughter of the late Mr. William Smith, died on the very same day in the South of France.

THE LATE MR. CHARLES CHURCHILL.

Following upon our announcement, on page 159 *ante*, of the death of Mr. Charles H. Churchill, we regret to have now to record the death of Mr. Charles Churchill, the founder and senior director of the firm of Charles Churchill and Co., Limited, which occurred on Tuesday, the 15th inst. Mr. Charles Churchill was an American, being born in 1837 at Hamden, Conn., U.S.A. His father was a manufacturer of auger-bits and similar tools.

Mr. Churchill first came to England in August, 1861, to set up and work a plant of braiding-machines in connection with the orinoline trade. In the course of his work he required from time to time to purchase various tools, and, being unable to obtain in this country exactly the type which he needed, he sent over to the United States for supplies such as Cushman chucks, Morse twist-drills, drill-chucks, auger-bits, expansion-bits, &c. As friends became acquainted with these tools, he ordered a number for them also, and when change in fashion caused his original business to fall off, he gave his attention to the question of importing tools from America as a serious business proposition. He made a market for them, and in 1865 he took an office in Ducksfoot-lane, Laurence Pountney-hill, where he commenced trading under the name of Charles Churchill, American Merchant. On its gradual growth, the business was transferred to larger premises in the City ; in 1872 it was carried out under the style of Charles Churchill and Co. ; and in 1896 the present premises in Leonard-street, Finsbury, were taken over.

In 1890 a small branch was opened in Birmingham to deal with the Midland counties ; this has since grown to such an extent that it is now housed in a building of its own. In 1898 an office was opened in Manchester. A workshop was also started a little later in Manchester for the manufacture of tools ; this progressed so rapidly that in 1906 a separate company was formed of the concern under the title the Churchill Machine-Tool Company, Limited, with Mr. Churchill as chairman. The function of this company was to manufacture certain machines on behalf of Messrs. Charles Churchill and Co., and it has specialised most successfully in precision grinding-

machines of all kinds. The works in Pendleton cover a large area and occupy at the present time 500 men. The staff of Messrs. Charles Churchill and Co., which about thirty years ago numbered less than one dozen, all told, including Mr. Churchill and his three sons, now numbers close upon 200, a large proportion of whom joined His Majesty's Forces in 1914.

Mr. Churchill resigned the chairmanship of the company a few years ago, owing to failing health, but continued nevertheless to attend regularly to the business. The work of actual management passed some years before into the hands of his eldest son. Mr. Churchill was, we believe, the senior member of the American Society in London, on the committee of which he also served. He was known and respected by a very wide circle of business friends. His two remaining sons, Messrs. Arthur and Willis Churchill, remain in the business, with which they have been connected for a large number of years.

INDUSTRIAL NOTES.

The Army Council have issued an Order regulating the conditions under which soldiers released from active service for munition work are employed. This states that the man will continue to draw his ordinary Army pay until the date on which he starts work with his civil employer. Thereafter he will draw civil pay as earned, and all Army emoluments will cease, except as stated below. If the civil pay earned for any week falls below his weekly rate of Army pay and allowances, the amount of the deficiency will be made good to the soldier by the employer, subject to any rights of reimbursement, except in so far as the deficiency is due to the soldier's own fault. In case of sickness or injury, in the event of the benefits for which the soldier is eligible under civil conditions (including the sickness and disablement benefits) under the National Insurance Act, and any payment due from the employer under the terms on which the man is engaged, or under the provision of the Workmen's Compensation Act, being less than his rate of Army emoluments, the amount of the deficiency will be made good to the man by his employer, provided that a certificate is received from the man's medical attendant to the effect that the man was unfit to follow his employment for the period in question. In cases in which the soldier while in civil employment is unavoidably separated from his family or dependants, separation allowance (less the allotment portion) will be issuable to the wife or other dependants under the usual conditions as a clear addition to any other earnings or emoluments of the soldier.

The Order adds that soldiers on munition work are, when employed in an insured trade, to be treated as insurable under the Unemployment Section of the Insurance Act. It also states that soldiers and their families and their dependants will remain in possession of all their rights and privileges in regard to pensions, &c., as though the men had continued to serve as soldiers.

An appendix prescribes that soldiers transferred to civil employment will in all cases be supplied with necessary Army clothing. In addition, one suit of khaki overalls will be supplied. Renewals of clothing will be obtainable; provision is also made for a kit allowance of 2½d. a day for small articles.

The Minister of Munitions has now issued (under Section 5 (6) of the Munitions of War (Amendment) Act, 1916), rules, entitled the Munitions (Leaving Certificates) Rules. These rules define the position of employers and workpeople, modified as from February 28 next, in respect of the leaving certificates required by workmen engaged upon munition work in certain classes of establishments.

The principal changes made in the leaving-certificate system relate to cases in which workmen are dismissed, discharged, are suspended for more than two days without an opportunity of earning, or leave on account of conduct on the part of an employer or his agent which would justify the termination of a contract of service.

It is provided that employers must grant leaving certificates in such cases, and that a workman may recover damages if he fails to do so. One week's notice, or wages in lieu of notice, has also to be given by employers in certain circumstances.

The Ministry of Munitions has in preparation two explanatory memoranda upon the subject of leaving certificates for the guidance of employers and workpeople respectively. Copies of these memoranda, as well as of the leaving certificates rules, will shortly be obtainable, free of charge, on application to the Ministry of Munitions, 6, Whitehall Gardens, S.W., or to any Labour Exchange.

From the inception of the munition tribunals up to the end of the first week in February, 1916, 555 workmen have been convicted for striking, the average fine working out at a little under 30s per man convicted. Employers to the number of seventy-one have been convicted of enticing workmen away from their employment and have been fined on an average over 5*l.* each, exclusive of costs. Before the local tribunals the greater number of cases have been applications by workmen for leaving certificates to entitle them to cease their present munitions employment and take employment elsewhere. There have been 5658 of these applications, of which 1447 were granted and 2510 refused, while 1472 were withdrawn or dismissed, the great majority of those being withdrawn owing to the employers consenting to grant a certificate. In 229 cases the Court decided that no certificate was required. There have been altogether 4054 convictions for breaches of workshop rules, for which fines to the amount of 3292*l.* 15*s.* (just over 16*s.* per man convicted) were inflicted. Of the cases of this kind 829 were dismissed by the Court and 1888 were withdrawn.

A meeting of the workmen employed in the engineering departments of Messrs. Palmers' Shipbuilding and Iron Company was held at the Mechanics' Institute, Jarrow, last Saturday, the 19th inst., when Sir George Croydon Marks, M.P., delivered an address. Speaking from information obtained personally from the First Lord of the Admiralty, the President of the Board of Trade, and the Minister of Munitions, he could assure them that this country had a fearful domestic crisis in front of it unless some extraordinary means were at once taken to increase alike our production of warships and of mercantile vessels and our munitions of war. All these necessities were demanding a supply from one body of workers concerned having skill that could not be acquired in a month or a year, seeing that shipbuilders, engine-fitters, turners, machinists, and the other skilled operatives alone could do the higher class of the work thus demanded, and these men needed years of apprenticeship and experience before they could be satisfactorily employed on such work. These same men, however, did not need always to be using their full skill upon many of the jobs upon which they were engaged. The proposal, therefore, was that the skilled men should be released from the less skilled portion of the work, and unskilled men and women be transferred, after proper training, to undertake the simpler work, leaving the highly skilled man thus at liberty to render greater national service during the war by devoting all his time to the better work that none but a highly skilled man could or should undertake.

Sir George emphatically assured the men that Parliament and the Coalition Government had recorded assurances that the concessions of customs due to the war should not be allowed to alter a trade-union privilege or practice after the war, and that neither employers nor workpeople should be given the power to use the war to extort alterations in working that would not be demanded or conceded in time of peace. The schemes of dilution he had, with the authority of the Government, introduced provided safeguards against a wanton shifting of a worker or a prejudice in any way being created by the men's surrender of their rights and customs in their desire to do their part at home while their comrades did their part in the trenches or battleships. What kind of sacrifice was theirs in giving up a custom, relaxing a condition, removing lines of demarcation between one man's work and another's, even if it did bring with it a risk of weakening for the moment a trade, when compared with the sacrifices those engineers, their comrades, had made, who not only gave up their well-paid trades, but gave life and limb too, in their desire to fight the common foe seeking to take not only trade, but liberty and life, from every soul in the Empire? He earnestly appealed to the men to work this dilution with a will that would make for a greater output, to show no jealousy or make noisy bickerings, grumblings at those whom they should welcome alongside of them in this hour of extreme national crisis in which their own trades were so intimately involved.

At the close of the meeting a resolution was moved and seconded in favour of accepting the principle of dilution, provided that a register should be kept of all operations and persons involved. The resolution was carried with only three dissentients.

The Management Committee of the General Federation of Trade Unions, in its sixty-sixth quarterly report, dated December, 1915, states the following:—

"The management committee has given serious consideration to the problems which will follow upon the conclusion of peace and the demobilisation of the Army. It has pressed for a number of things in connection with the naval and military pensions—that they should be adequate, guaranteed by the State, capable of registration just as easily as a workman's compensation claim, and that steps should be taken to prevent them being used to reduce wages. The latter point can be best achieved by the organisation of returning sailors and soldiers, and trade unions should give early and serious attention to this aspect of the coming situation. In the crises to come it will be better to have these men with the movement than against it. Already the agents of the Free Labour Association are at work, and they will forestall the unions unless these act immediately and intelligently. Where it is necessary to alter rules the alterations should be considered as soon as possible, and both the willingness of the unions to accept sailors and soldiers and the conditions of membership should be advertised. It will be advisable for the unions to advertise in the Service papers, or, better still, they might combine through the General Federation to run joint advertisements.

"The management committee has taken its stand on the question of conscription. Its attitude cannot be better stated than it is in the two following resolutions:—

"The management committee of the General Federation of Trade Unions is convinced that nothing in the existing situation justifies the campaign in favour of conscription, because recruiting is proceeding satisfactorily. That those who are responsible for this campaign in favour of conscription are clearly actuated by partisan and financial considerations, and by their selfish and revolutionary propaganda they are jeopardising national unity and the successful prosecution of the war.

"The management committee whilst reiterating its opposition to the measure desires to associate itself with the rest of the Labour movement in an organised effort to secure on a voluntary basis all the men that are required to bring about a successful termination of the war. . . ."

President Meyer, of the Association of German Iron and Steel Manufacturers, at a recent general meeting said, according to the *Iron Age*, "that if the German iron and steel industry had not been sound, strong and capable of producing more than was needed by the home market, it could not have met the enormously increased strain of the war, and Germany, being unable to fall back for her requirements on the United States, could not have held out. Dr. Reichert, Director of the Export Department, stated in his report, read at the same meeting, that 'in the first months of the war the German raw steel output fell to little more than one-third of the normal peace output, but in March, 1915, it again exceeded the 1,000,000-ton mark, and in October amounted to 1,215,000 tons, or 77 per cent. of the average peace output . . . Practically all the existing German steel works, numbering 130, had taken up the manufacture of war material, and in the course of the war no fewer than seventy firms had built new steel plants. It would not be an exaggeration to say that, counting all the plants which are making shells, from 1600 to 1800 are now engaged in the production of munitions.

'The maintenance of export business is a matter of urgent necessity, both with an eye to the present and to future American competition. The American industries—adds the report—are strongly interested in the continuation of the war, as is apparent from the increase in the exports of iron and steel from the United States, and in view of the threatening American competition after the restoration of peace, Germany must maintain her existing industrial trusts, and even create new ones.

'With regard to the commercial policy after the war, the Association is clear upon the following points:—The protective system of Germany, inaugurated by Bismarck, must be maintained. Germany must lay down the conditions upon which her goods are to be exported to the principal foreign markets. She must see that her products are placed upon an equal footing with those of other countries in foreign markets. Where necessary, German Customs duties must be raised, so as to render the country independent of foreign goods.'

"A telegram was sent to the Imperial Chancellor stating that the Association was able to supply the armies of Germany and her allies with all necessary munitions and other war material for many years to come, and at the same time to supply whatever the home and neutral markets might need for ordinary trading purposes."

To the above we shall only remark that if "the raising of the German Customs duties" has for effect "to render the country independent of foreign goods," Germany is a self-supporting nation. Apart, therefore, from the present fall in Customs revenue, why her present tearful complaints against our blockade?

A meeting of members of the British Association of Managers of Textile Works was held in Manchester on Saturday, the 19th inst., with a view to consider the present scarcity of labour. The following suggestions were put forward as a means of solving the difficulty:—

Employment of supplementary unskilled labour for work such as cleaning, the carrying of weft and cloth, &c., so that the number of looms tended by weavers could be increased from four to six or possibly eight.

Reduction of the working hours for adult labour from ten to nine per day as an incentive to people to

enter mills. In the case of juvenile labour the starting hour to be 8.40 a.m. instead of 6 a.m. Temporary lowering of the school age only if combined with the above reduction of hours for young children. Juvenile training in the various sections of the cotton mill. Registration of all available children throughout the country, or at least in industrial centres. Juvenile advisory committees to consist of men who are intimately connected with the local trades. A freer interchange of labour of operatives in the various sections of the mill and encouragement to people not previously employed to assist where possible. Employment of discharged and partially disabled soldiers on unskilled occupations in the mill, of which there are many.

In the course of the meeting, the chairman (Mr. A. Pollitt) said the difficulty in the cotton trade was not lack of work, but lack of workers. The first suggestion to overcome the scarcity of male labour was always the same—the substitution of female labour; but there was a scarcity of female labour in many districts before the war began. Why, he asked, should the largest, most highly organised, best paid, and most skilled labour open to women in this country carry with it the longest number of hours and the most arduous conditions? Before the war women and girls were being attracted in increasing numbers to other occupations, not so well paid, but with shorter working hours. During the present crisis it could not be said that the cotton trade had appealed very strongly to the available female labour. In considering the shortage of male labour, as distinct from female, it was necessary to remember the higher rates now paid in occupations outside the mill. The cotton trade to-day was a bidder in the open labour market in competition with new and specially favoured industries. Although this would to a great extent readjust itself with the return of peace, they were compelled to try to find a solution for what was immediately before them. With men, as with women, the problem was also a permanent one. The introduction of a more progressive system of training in the higher skilled occupations might be entertained, with a wider recognition of their claims to rank as trades and the operatives as skilled artisans. They needed greater freedom than the present trade-union restrictions allowed in the number of learners they might have in training.

The Cleveland Twist-Drill Company, Cleveland, Ohio, says *Machinery*, New York, has put into effect a system of profit-sharing with its employees, of which the following are a few of the clauses:—

Before any profits are divided with employees, the stockholders shall receive 8 per cent. per annum.

When the above 8 per cent. has been paid to the stockholders in any calendar year, all cash dividends subsequently declared in that year will be divided between the stockholders on the amount of their stock interest and the employees on the amount of the salary or wages received by them during the twelve months ended June 30 of the year, as follows:—(*a*) Employees who have been continuously in the service of the company for at least two years prior to July 1 will receive dividends at the same rate as the stockholders; (*b*) Employees who have been continuously in the service of the company for more than one year and less than two years prior to July 1 will get three-quarters of that rate; (*c*) Employees who have served continuously for less than one year will get one-half the rate of the stockholders; (*d*) Dividends that have accrued will be distributed to employees once a year, in December, except that dividends for the year 1915 will be distributed in January, 1916.

Any employee who may receive a commission from the company or any share in profits other than the profits shared in this plan, except through dividends of stock, if a stock-holder, shall thereby be rendered ineligible to receive dividends under this plan.

The above plan for division of profits is absolutely voluntary on the part of the company, and is in no sense a contract. The company can make at any time such changes in the plan as they may consider desirable for the best interests of the organisation. The fact that any employee is receiving dividends in the profit-sharing plan shall not deprive the company of the right at any time to discharge the employee, and thereby terminate his participation under the plan; nor shall any employee acquire any right thereunder to any accounting by the company concerning its business or profits.

NEW ZINC WORKS IN NORWAY.—At Drammen, Norway, new zinc works are about to be started for the extraction of zinc by an electric wet process, invented by a Belgian engineer, M. Sturbelle. The method will be exploited by a company under the style of Norwegian Zinc Electro-Metal No. 1, and the capital of 22,000*l.* has been subscribed. The operations are to commence in the autumn of the present year, and the output to begin with has been put at 2 tons electrolytic zinc per 24 hours. Raw materials for the first year, about 10,000 tons, have been secured, and special attention will be paid to ores containing from 8 to 30 per cent. of zinc, which have hitherto been considered as really worthless.

THE MAIN DRAINAGE OF CAIRO.*

By CHARLES CARKEET JAMES, M. Inst. C.E.

THE paper commences with the history of the steps taken by the Egyptian Government for the drainage of Cairo from 1885 to 1906, and then describes the scheme as subsequently designed and carried out by the author, and officially inaugurated by H.E. the Minister of Public Works on March 22, 1915.

The City of Cairo and suburbs, included in the scheme, covers an area of 7538 acres. It is drained on the sectional and gravitation systems, the sectional portion using compressed-air ejectors. After giving details of the rainfall, water consumption, population, and sanitary conditions of the city, the paper deals with the treatment of surface water for the whole city and suburbs, and describes the machinery, ejectors, and mains installed for dealing with about 9 million gallons per day.

Next, the sewer reticulation and the compressed-air system and its machinery are dealt with. Sixty-three ejectors in cast-iron tubbings have been sunk, with 50 miles of cast-iron air-mains and sealed sewage-mains. The air-compressing plant consists of four steam-driven compressors, each capable of compressing 1770 cub. ft. of free air per minute to a pressure of 22 lb. to 25 lb. per square inch. The main collector is 14,900 yards in length, 5 ft. 3 in. in internal diameter, constructed in cement concrete, and laid with a gradient of 1 in 2500. The construction of this collector, the plant used, and the methods and cost of unwatering the trenches are described.

The next section deals with the screening-chamber, sump, and main pumping-station at Kafr-el-Gamus, and gives details of their design and working. At Kafr-el-Gamus the sewage is received from the main collector, and pumped to the purification works and farm at Gebel-el-Asfar. The construction of the sump is briefly touched upon. The pumps, boilers, &c., are designed to deliver 50 cubic metres (11,000 gallons) of sewage per minute against a head of 250 ft. The plant consists of four units, three of which are capable of dealing with the maximum flow. The pumps are of the triple-plunger type, and are placed immediately over the sump. Each steam-engine develops 200 horse-power at a normal speed of 22 revolutions per minute, but is capable of developing 360 horse-power at the maximum speed of 32 revolutions per minute. The engines are arranged for quadruple expansion, and each has its own condenser placed under the engine floor.

The rising main is 36 in. in internal diameter, constructed of cast iron, and 7¼ miles in length. The flow passing through this main is registered by a Venturi meter, and controlled at intervals by sluice and reflux-valves. A complete description of this main and of the testing of the pipes is given.

The purification works at Gebel-el-Asfar are designed to treat 11 million gallons per day through six hydrolytic tanks and eight continuous filter-beds, with storage-tanks for holding up the night flow. A description of the method and results of treatment is given, and the necessary machinery for supplying the power needed for driving the pumps, distributors, and other mechanical appliances and for the lighting is described. The plant consists of three semi-Diesel oil-engines of 60 horse-power, each direct coupled to 45-kw. dynamos, from which the electrical energy is transmitted to various points by overhead cables.

For the Gebel-el-Asfar farm about 3600 acres of desert land has been reserved. The methods of irrigation and cultivation, and the earlier experiments carried out to decide upon the agricultural policy to be followed, are described, as well as the accommodation provided for the staff and farm labourers; and the prospects of the farm with regard to cultivation and returns are discussed. Owing to the absence of rain, desert land only requires continuous irrigation, and in the vicinity of a city such as Cairo it should prove very remunerative. Finally, the system of taxation to meet the cost of the drainage and the costs of the scheme are dealt with.

CONSTANTS OF CAOUTCHOUC.—The elastic properties generally associated with rubber are not confined to what is known as "caoutchouc," but are found to a certain extent in some other colloids of high molecular weight. In recent researches carried out in Russia, I. Ostromisslenski and M. Kelbasinskaya (*Journal of the Russian Physical-Chemical Society*, 1915, pages 1374 and 1401) suggests the name "resinoids" for such substances which are elastic, like rubber, and capable of vulcanisation. The name is derived from the Russian name for rubber (rezina), and is unfortunate in so far as it is customary to distinguish the real rubber, or caoutchouc, from the resinous substance generally accompanying it. In all cases the elastic properties vanish when the temperature sinks below a certain minimum (−20 deg. Cent. in the case of caoutchouc, which itself then turns like leather), and are permanently destroyed when the material is heated above another certain temperature; for these two temperatures the terms "temperature of elasticity" and "fatal temperature" are proposed. These two temperatures are characteristic for every resinoid, and may be determined, in solutions, from the viscosity, the density, and the surface tension of the liquid, all the three methods leading to identical results. Some artificial caoutchoucs are considered as normal (when they have approximately the constants of natural caoutchouc), others as abnormal. The regenerated rubber is never normal; its temperature of elasticity lies above 100 deg. Cent. and varies with the methods of vulcanisation and regeneration.

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* Abstract of paper read before the Institution of Civil Engineers, on Tuesday, February 22.

PRICE MOVEMENTS OF THE GERMAN STEEL UNION.

AT the last meeting of the German Steel Union a further rise in prices was decided upon, to come into operation for the second quarter of the present year, for those commodities which are subject to such fixed price regulation—that is, half-finished products and shape iron; whilst the prices for railway material, of which the State railway authorities are the principal buyers, are regulated in contracts extending over a year or, as a rule, even longer periods, and adjusted according to circumstances. As regards the present increase in the price for half-finished goods, it may be noted that in this instance no price has been fixed for the whole class of goods, as has hitherto been the case, but a graduated scale has been applied to the different articles. Whilst the increase for billets in the second quarter of 1916 only amounts to 5 marks, the rise for bundle iron was put up 7 marks 50 pfennigs per ton, and that for plates 10 marks per ton. These rises in the quotations are attributed to the increased cost of production.

The following table shows the fluctuations in the quotations of the German Steel Union from the beginning of the war to the present day:—

	Billets.	Bundle Iron.
	Marks per Ton.	
Commencement of war ...	87.50	95.00
Third quarter, 1914 ...	95.00	102.50
Second quarter, 1915 ...	102.50	110.00
Third quarter, 1915 ...	107.50	115.00
Second quarter, 1916 ...	112.50	122.50
	Plates.	**Shaped Iron.**
	Marks per Ton.	
Commencement of war ...	97.50	110.00
Third quarter, 1914 ...	105.00	110.00
Second quarter, 1915 ...	112.50	120.00
Third quarter, 1915 ...	117.50	130.00
Second quarter, 1916 ...	127.50	140.00

The rise during the war of the above four descriptions of goods is thus respectively 25 marks, 22.50 marks, 30 marks, and 30 marks per ton, but it should be borne in mind that the prices when the war broke out were at a somewhat low level, on account of the industrial depression which then prevailed. It will be seen that the former quotations remained in force for nine months.

It is generally accepted that the fact of the Steel Union having raised their prices will influence other iron and steel quotations in the same direction, and that this will apply both to pig-iron and steel products further handled, such as bar-iron, plates, pipes, &c. The Pig-Iron Union has only given January and February free, wishing to see what the Coal Syndicate would do in connection with prices after March 1, 1916, and also waiting for the steps now taken by the Steel Union. The prices for rolled products, after a tendency to somewhat lower quotations last autumn, have been kept at a level marked by a price of 130 to 135 marks per ton of bar-iron, but of late the tendency has been somewhat firmer.

THE DANISH H. C. ORSTED MEDAL.—The Danish H. C. Orsted medal was, on February 16, in the presence of the King of Denmark and a large number of eminent scientists, presented to Professor Martin Knudsen for his theoretical and experimental researches and investigations of the physical qualities of gases. Professor Hannover, the director of the Copenhagen Polytechnical High School, where the presentation took place, and Professor Prytz, having each paid their tribute to Professor Martin Knudsen, the latter delivered an address, in which he stated that his labours had principally been directed towards a more exact investigation and development of the kinetic gas theory and an experimental testing of its consequences. From the assumptions of the kinetic theory the law of statistics could be applied to the movement of the molecules of gases. Having, for instance, calculated how much air in a certain time flows through a tube of given dimensions, when there is a fall of pressure in the tube, the experiments have yielded a complete numerical conformity with the calculations, and it is the first time that the theory has been made to yield exact numerical results. Having touched upon the movement of the electrons, Professor Knudsen gave some information about his work during the last year, which had principally been centred upon the conditions for the rejection of the molecules of metals from a solid or liquid body. Although these investigations were not concluded, he thought he could state as a result that when a molecule of metal comes from without and collides with a metal of the same kind, which is solid or liquid, then the metal molecule will be absorbed in or on the body against which it has collided, irrespective of the temperature of that body. The result is different when a metal molecule—for instance, a quicksilver molecule—hits another substance, for instance, a glass wall. When the temperature of the glass wall is above 140 deg. Celsius the molecule can be rejected by the glass wall; if the temperature is lower, the molecule will adhere at the first touch. If the temperature of the glass, for instance, is − 75.5 deg., a colliding quicksilver molecule will only have a probability degree less than $\frac{1}{2^{100}}$ for adhering at the first touch. This probability motion no doubt plays a part in the phenomena called the super-saturation of steam and in other unstable states. In honour of Professor Martin Knudsen, his Excellency M. Hagemann, the former Director of the Polytechnical High School, presented a substantial sum, to form a scholarship bearing Professor Knudsen's name.

"THE NOMENCLATURE OF INTERNAL-COMBUSTION ENGINES."

To the Editor of Engineering.

SIR,—With reference to the article on the "Nomenclature of Internal-Combustion Engines," in your issue of February 11, I certainly agree with the opinion expressed therein, that some standardisation of the various technical terms used in conjunction with oil-engines is becoming imperative.

Unless one is thoroughly acquainted with the development of oil-engines, it is quite conceivable that it must be extremely difficult to comprehend the difference between such terms as "crude-oil" engine, "semi-Diesel" engine, "Diesel" engine, "high-compression" oil-engine, "hot-bulb" engine, "constant-pressure" oil-engine, and others.

"Crude-oil" engine is a term originally employed to distinguish an engine using a very light gas or solar oil as fuel from that type which burns kerosene, or paraffin, as it is called universally, though quite wrongly.

When the Diesel engine came to the front, an engine that actually did burn a crude oil, in addition to residuums, whenever it was found advisable, the term "crude-oil" engine, which would have been quite correct to employ, but which had by then become the standard expression for something else, could not be used, with the result that "Diesel" engines became the recognised term.

When the so-called "crude-oil" engine had passed through a series of modifications, which included the adoption of higher compression pressures and various shapes of vaporisation surfaces, the term "semi-Diesel" was introduced. The main reason for such a nomenclature may probably be found in the fact that this new type could burn an oil of gravity lying about half-way between the gravities of oils used in "crude-oil" and "Diesel" engines respectively.

Coming now to the question of a suitable term for each of the different types, I certainly do not think it practical to embody a constructional feature, such as "hot-bulb," "vaporisation-plate," "air injection," or "mechanical injection," a term which is used amongst oil-engine experts in preference to "solid injection." There exists no doubt that the compression pressure is one of the governing factors for determining whether or not a certain grade of oil can be burnt in any particular type.

Consequently it is my contention that the term "pressure" should be used to define the type of engine. Let it be "low-pressure" oil-engine, "medium-pressure" oil-engine," and "high-pressure" oil-engine, instead of "crude-oil," "semi-Diesel," and "Diesel" engine respectively.

To ensure the general application of any term it must be compact, and although the above expressions do not compare very favourably with "Diesel" engine, they can hardly be termed clumsy.

Without any disrespect to Dr. Diesel's work, I am sure that "Diesel" will pass out of use just as "Otto" passed out of the practical dictionary of the engineer. Diesel, it seems to me, is always used to impress prospective customers or the non-technical readers and inspire them with confidence.

As to the other many terms, the whole question rests on being a little more precise when defining a certain part, and rather including an additional word in the descriptive matter instead of risking confusion with another part.

With regard to the term "two-stroke" and "four-stroke" cycle, there should be no doubt that such term is to be preferred to a "two-cycle" or "four-cycle," as being technically correct.

Yours faithfully,
J. L. CHALONER, R.E.

London, February 23, 1916.

NAVAL GUN-MOUNTINGS.

To the Editor of Engineering.

SIR,—Please allow me to make a few remarks in your journal regarding the development of big naval gun-mountings. Although it may be said that these machines have no general interest to engineers, they are nevertheless, perhaps, the most valuable engineering possessions of the country at the present moment.

A big gun-mounting is a vast collection of machines and devices assembled around the gun for the purpose of accurately aiming and rapidly loading the same. It has, in so far as it performs these functions correctly, all but reached perfection. There is no great secret concerning nine-tenths of a British big gun-mounting, for practically the same article is sold by the makers to foreign countries, and descriptions and drawings occasionally appear in engineering papers. The double-page plate in ENGINEERING, July 31, 1914, shows an hydraulic 12-in. gun-mounting made to typical British practice.

If the aiming machinery—*i.e.*, the elevating and training machines, gear, and control—fulfil what is required of them, and if the loading-machines, together with their gear, &c., also perform their part, at a speed equal to the maximum rate it is desirable for a gun to be fired without excessive heating, then the question arises as to what further advantageous development can be made. Of course, one can go on altering their design for ever, such as replacing hydraulic presses by hydraulic engines, reverting to fixed loading, re-arranging the machines in the turret, and so on; but these are not engineering advances, only mere draughtsmanship. With the exception of the addition of director fire-control in recent years, a sort of dead staleness seems to be setting in.

Now admitting that a modern big gun-mounting acts with perfection, there is yet very much scope for further progress being made by true inventive engineering, apart from the process of modifying, and there are two directions in which future progress lies. First, simplification; second, self-action; both by means of new inventions. These two objects are utterly impracticable. (It would, of course, be possible for a few experienced men to work out an automatic mounting; but the result would be so ridiculously complicated as to be not worth consideration—that is, without new inventions.) For example, the invention of a high-speed hydraulic engine has simplified training, rendered director training possible; and what is director training but a step towards automatic action? The invention of churn-lever control simplified the various motions necessary for gun-loading, and it is also a step towards automatic mountings.

There are hundreds of engineers employed on this branch of engineering. Millions sterling are spent on it. The chances are there, and if we do not take them "others" will.

I am, Sir, your obedient servant,
February 19, 1916. ENGINEER.

ELECTRICAL POWER PLANTS IN THE THAMES.

To the Editor of Engineering.

SIR,—Mr. Dean's letter, which appeared in your issue of January 21, page 67, describing his scheme for centralising London's source of electricity supply to several power plants situated on islands built in the river, displays a lack of regard for one of the most important sources of fuel supply which, had it not, apparently, been overlooked by those responsible for the more modern metropolitan power schemes, would have relieved much of the anxiety now shown at the increasing cost and scarcity of that particular class of fuel necessary for the type of automatic stokers with which these stations have been, and are still being, equipped. I refer to the abundant and ever-increasing surplus of smokeless gas-coke available on the Thames, the use of which, for a new power plant, should not involve questions of transhipment and storage, as the fuel is already *in situ*, with ample provision made for storing adequate reserve stocks of the raw material from which it is made.

In a power-supply scheme developed with a view to taking full advantage of this source of fuel supply, the questions of overload capacity and load-factor would be met to a great extent by augmenting during periods of sudden and peak loads the normal solid-fuel capacity of the boilers with a gaseous fuel supply, also abundantly procurable from the same source. From the national standpoint, the most that is possible would be obtained from the coal used by means of existing by-product recovery plant. Why duplicate such plant on a relatively small scale at isolated power-stations? As the present output of coke from the metropolitan gas supply companies' works is considerably in excess of the aggregate coal consumption of the combined electricity-supply stations, it would appear that the necessary railway sidings, wharves, &c., for handling the raw coal already exist. In a power scheme sufficiently comprehensive, these, in my opinion, would form the natural starting-point.

Yours faithfully,
E. W. L. NICOL, Assoc. I.E.E.
84, Horseferry-road, Westminster, S.W.,
February 17, 1916.

BRITISH PATENT LAWS AND FUTURE GERMAN TRADE.

To the Editor of Engineering.

SIR,—I quite agree with your correspondent "Mernok" in the issue of ENGINEERING of the 11th inst., page 129, wherein he implies that inventors and manufacturers should certainly awaken to the unsatisfactory state of our legislation in the matter of patents; but I would like to remark that I think the awakening should be more on the part of the inventors and manufacturers that at present on that of the legislators. Both in Germany and America the patent question, from a commercial point of view, has been thoroughly studied by every firm which possesses patents, to the enormous benefit of its business. This matter has been neglected in this country. There are firms who own many patents who, after an order or two have been received for them, forget all about them if a period of quiescence occurs round about the subject-matter. They employ no one to watch and nurse it commercially.

When each firm possessing patents chooses, as they should do, thoroughly to study, nurse and increase their patent goodwill, a lot will be done towards increasing this country's commercial supremacy, which it is rapidly losing, partially through neglect of this nature.

I do not agree with "Mernok" in his wholesale strictures upon the Patent Rules. During my fifteen or so years' experience with the Patent Office I have not found their regulations "vexatious," and I cannot see that the "penalising stipulations" are so objectionable as "Mernok" states.

"Mernok" asks, for instance, why should an application for a patent have to be accepted within fifteen months. I would like to ask why it should not be accepted sooner than twelve months, if it can be, because the inventing public has a right to have a possible anticipation of the inventions which it may be working on brought before its notice as soon as ever possible. If we are to adopt the methods of America and Germany, as he suggests, it may be years, as in those countries, before a man is aware that he has been inventing on the same lines as others which are held up from publication, and to which, therefore, he has no access.

"Mernok" says, again, that the Patent Office seems always to be "on the make" for every little infraction of the Rules, citing the International Convention as an example. He says: "Why should a foreign applicant be compelled to file a certified copy at the same time as the application for the British patent, or else have to pay a fine?" As a matter of fact, I believe I am right in stating that the Patent Office has been obliged to institute penalisation by reason of the fact that, as there was no penalisation, inventors made a practice of not promptly producing the certified copy of the foreign application. As it is a stringent condition that the British application shall conform in all points with the foreign application (it may, however, be limited, but not broadened), it is obvious that unreasonable delay would occur, nor could the application be considered by the Comptroller until the certified copy of the foreign application was on file. This is a very important point when the applicant might delay filing his British application to the very day twelve months corresponding to the orginal. It must not be forgotten that the British specification becomes open to the public inspection on that same date.

In my opinion, fourteen years is quite long enough to grant any monopoly, and an inventer nowadays has a fair chance of getting a patent renewed for a further period of seven years, should he be able to show that it has not been sufficiently remunerative, possibly by reason of conditions which are not under his control, nor by his fault.

Friction with the officials at the Patent Office might be expected to arise as the result of these alleged "vexatious" rules. As a matter of fact, I believe, this rarely occurs with any official on the staff of the Patent Office. As far as I am concerned, a more obliging and reasonable staff I do not wish to search for, and, above all, I am quite satisfied that the examiners, as a body, are second to none in efficiency.

With reference to "Mernok's" remarks with regard to a moratorium, I do not understand what he means; but I think he will find, if he inquires, that, in spite of the absence of a moratorium upon renewal fees, intimations in the *Patent Office Journal* suggest that the Comptroller has it in his mind to reciprocate in regard to matter of this kind, if the enemy reciprocates.

Yours faithfully,
February 22, 1916. H. J. T.

THE OPTICAL SOCIETY.—Mr. F. J. Cheshire, of the Optical Branch of the Ministry of Munitions, has been elected President of the Optical Society, in succession to Dr. William Ettles.

SOURCES OF ZINC WITHIN THE BRITISH EMPIRE.—The large amount of zinc required for war purposes, and the resulting enormously increased demand for the metal, lend special interest to an article in the current number of the Bulletin of the Imperial Institute, on "The Occurrence and Utilisation of Zinc Ores." The chief zinc minerals are described, and a brief account given of the more important occurrences in the United Kingdom, the Colonies, and India. Zinc ores have been mined in many parts of the United Kingdom, notably in Cumberland, Northumberland, Durham, Derbyshire, Shropshire, and the Isle of Man, but a large proportion of the production has for several years past been shipped to the Continent for smelting. By far the most important zinc deposits in the British Empire are those of Broken Hill Mines, New South Wales, the output of which alone is sufficient to supply the entire demands of the United Kingdom for metallic zinc. The Broken Hill ore before the war went mainly to Germany for smelting, but the Australian Government has adopted measures which will prevent this in the future. Zinc is also found in South Australia, Queensland, Tasmania, New Zealand, and Newfoundland. Canada contains a number of workable zinc deposits, particularly in British Columbia, and there is every prospect of Burma becoming an important producer. In Africa there are zinc deposits in Egypt, Nigeria, Rhodesia, and the Transvaal, as to which more information is needed.

EUROPEAN AMERICAN INVESTMENTS.—The holdings of common or ordinary shares in the United States Steel Corporation by foreign investors were materially reduced last year. Fewer preference shares are also now held by Europeans, but the reduction in 1915 was by no means so sweeping. At the close of 1915 there were 696,631 common shares in direct foreign ownership; the corresponding number similarly held at the close of 1914 was 1,193,064 shares, and at the close of 1913, 1,259,055 shares. The reduction last year in the number of common or ordinary shares held by foreign investors was as follows:—United Kingdom, 357,875; Holland, 104,028; France, 14,344; Canada, 16,248; Germany, 1476; Switzerland, 203; Italy, 134; the Austro-Hungarian Empire, 158; and other countries, 1967. Last year's reduction still left the following number of common shares in foreign ownership:—United Kingdom, 360,568; Holland, 238,617; France, 50,193; Canada, 38,011; Germany, 1147; Switzerland, 1267; Italy, 280; the Austro-Hungarian Empire, 532; and other countries, 6016. The number of preference shares held by Europeans at the close of last year was 274,588, showing a reduction of 34,342. The total of 274,588 was made up as follows:—United Kingdom, 164,428; Holland, 26,494; France, 32,524; Canada, 36,453; Germany, 1330; Switzerland, 2693; Italy, 2148; the Austro-Hungarian Empire, 3483; and other countries, 5035. It will be seen that the bulk of the foreign investments in United States Steel Corporation shares were held in Great Britain, Holland, France, and Canada.

CHISELS.

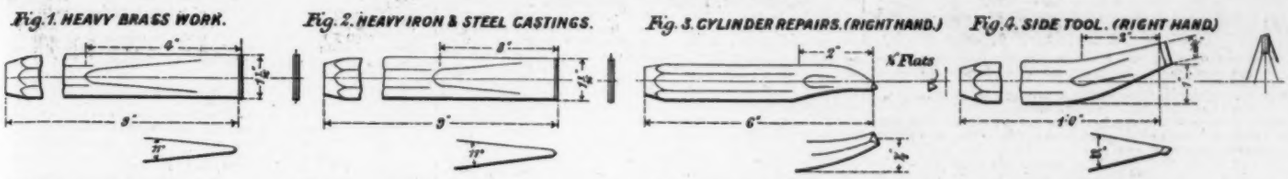
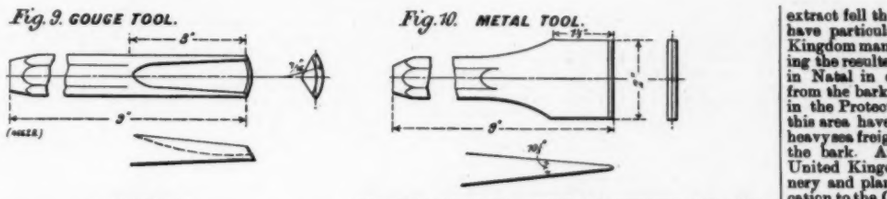


Fig. 1. HEAVY BRASS WORK.
Fig. 2. HEAVY IRON & STEEL CASTINGS.
Fig. 3. CYLINDER REPAIRS. (RIGHT HAND.)
Fig. 4. SIDE TOOL. (RIGHT HAND.)
Fig. 5. SQUARE NOSE.
Fig. 6. DIAMOND POINT FOR JAGGING, ETC.
Fig. 7. LONG CROSS CUT.
Fig. 8. ROUND NOSE.



CHISELS.*

By HENRY FOWLER, Member, Chief Mechanical Engineer, Midland Railway, Derby.

VERY considerable attention has been given to the composition and treatment of tool-steel used in machine-tools, but the three implements of the hand-worker—the file, the chisel, and the hammer—have been comparatively neglected. The author is aware of the work recently done in testing the former of these, and knows that there is little need of improvement with the last-named, but believes that the chisel has not received the systematic attention its importance deserves. A close examination of the new and used chisels in the shop over which he had control confirmed that view, and the result was an effort to induce the Alloys Research Committee of the Institution to take up the matter. For various reasons this was not successful, and so the matter has been dealt with individually.

The material usually employed for chisels is not bought to specification, but a well-known and tried brand purchased. In the Chief Mechanical Engineer's Department of the Midland Railway, after considerable experiment, it was decided to order chisel-steel to the following specification:—Carbon, 0.75 to 0.85 per cent., the other constituents being normal. This gives a complete analysis as follows:—

	Per Cent.
Carbon	0.75-0.85
Manganese	0.30
Silicon	0.10
Sulphur	0.025
Phosphorus	0.025

It is perhaps interesting to note that the analysis of a chisel which had given excellent service was as follows:—

	Per Cent.
Carbon	0.75
Manganese	0.38
Silicon	0.16
Sulphur	0.028
Phosphorus	0.026

The heat treatment this chisel received is unknown.

At the same time that chisel steel was standardised the form of the chisels themselves was revised, and a standard chart of these as used in the locomotive shops drawn up. Figs. 1 to 10 show the most important forms of these, which are made to stock orders in the smithy and forwarded to the heat-treatment room, where the hardening and tempering is carried out on batches of fifty. A standard system of treatment is employed here, which to a very large extent does away with the personal element. Since the chemical composition is more or less constant, the chief variant is the section which causes the temperatures to be varied slightly. The chisels are carefully heated in a gas-fired furnace to a temperature of from 730 deg. to 740 deg. Cent. (1346 deg. to 1364 deg. Fahr.), according to section. In practice, the chisel in Fig. 1 is heated to 730 deg. Cent., the chisel in Fig. 2 to 735 deg. Cent. (1355 deg. Fahr.), and a 1-in. half-round chisel to 740 deg. Cent., because of their varying increasing thickness of section at the points. Upon attaining this steady temperature, the chisels are quenched to a depth of ⅜ in. to ½ in. from the point in water, and then the whole chisel immersed and cooled off in a tank containing linseed oil. This oil-tank is cooled by being immersed in a cold-water tank, through which water is constantly circulated. After this treatment the chisels have a dead hard point and a tough or sorbitic shaft. They are then tempered or the point "let down." This is done by immersing them in another oil-bath, which has been raised to about 215 deg. Cent. (419 deg. Fahr.). The first result is, of course, to drop the temperature of the oil, which is gradually raised to its initial point. On approaching this temperature the chisels are taken out about every 2 deg. Cent. rise and tested with a file, and at a point between 215 deg. Cent. and 220 deg. Cent. (428 deg. Fahr.) it is found that the desired temper has been reached, the chisels are removed, cleaned in sawdust, and allowed to cool in an iron tray.

A question which naturally will be asked is, whether comparative tests of these chisels with those bought and treated by the old rule-of-thumb methods have been made. It must be admitted that the author knows of no method of carrying out such tests mechanically, other than that of hardness by the Brinell or scleroscope method, whilst any ordinary test depends largely upon the dexterity of the operator. The universal opinion of foremen and those using the chisels of the advantages of the ones receiving the standard treatment set out has, however, convinced the author of the improvement made.

The author is aware that questions may be raised as to why the chisels have not been normalised at about 900 deg. Cent. (1652 deg. Fahr.) after forging and before hardening. This matter had attention when the question was first dealt with, but at that time there were no facilities for carrying out this work. These have since been provided in connection with certain other work, but although various chisels have been normalised in the manner mentioned, no advantage has been found in carrying this out.

* Paper read before the Institution of Mechanical Engineers, Friday, February 18, 1916.

COLONIAL AND FOREIGN ENGINEERING PROJECTS.

WE give below a few data on several colonial and foreign engineering projects, taken from the *Board of Trade Journal*. Further information on these projects can be obtained from the Commercial Intelligence Branch, Board of Trade, 73, Basinghall-street, London, E.C.

New Zealand: According to an extract from the local Press forwarded by H.M. Trade Commissioner in New Zealand, a proposal of the Napier Borough Council to borrow the sum of 36,500*l.* for the purpose of carrying out drainage works in the Napier South district has been sanctioned.

Australia: According to the *Commonwealth Engineer*, Melbourne, the Municipality of Bendigo (Victoria) has decided to seek Government sanction for the installation of an underground sewerage system at that place, at an estimated cost of 100,000*l.*, and for permission to appoint an engineer to prepare plans and specifications. Plans are being prepared for a water supply system for certain defined areas in the districts of Ringwood and Croydon (Victoria). The *Commonwealth Engineer* also states that the Grafton and South Grafton Municipal Councils (New South Wales) have decided to adopt a hydro-electric scheme in accordance with a project prepared by the New South Wales Department of Public Works. The power will be obtained from the Nymboida River, and the project is estimated to cost 23,000*l.*

East Africa Protectorate: The Chief of Customs at Mombasa (the Board of Trade Correspondent for the East Africa Protectorate) reports that although, owing to the outbreak of war, a scheme for the erection of a factory at Naivasha for the production of wattle-bark extract fell through, planters of wattle would be glad to have particulars of machinery and plant from United Kingdom manufacturers. At present planters are awaiting the results of experiments which are being conducted in Natal in connection with the extraction of tannin from the bark. There are some 7500 acres under wattle in the Protectorate, and the trees on about one-third of this area have reached the barking stage, but owing to heavy sea freights it is not a profitable proposition to export the bark. An address to which communications from United Kingdom manufacturers of wattle factory machinery and plant should be sent may be obtained on application to the Commercial Intelligence Branch. In making application the reference number (44) should be quoted.

Spain (Canary Islands): The *Gaceta de Madrid* notifies that tenders will be opened by the Municipality of Las Palmas, on March 16, for the construction of a slaughter-house in that city. The estimated cost of the works is 298,095 pesetas (about 12,000*l.*). The installation of the necessary machinery, &c., for the slaughterhouse will be put up for tender later. The conditions of contract contain clauses to the effect that at the first competition the materials to be used will be confined, with certain exceptions, to products of Spanish manufacture, but that in the event of no decision being arrived at, a second competition, in which foreign products may be accepted, will then take place. In the latter event Spanish products will have a 10 per cent. margin of preference over foreign.

Brazil: The *Diario Official*, Rio de Janeiro, publishes the text of the Brazilian Budget (Expenditure) Law for 1916 (No. 3089), dated January 8, from which it appears that the total expenditure provided for in the Budget amounts to 405,266,062 milreis currency, and 84,365,086 milreis gold. The following item may be specially noted as of interest:—The Ministry of Ways and Communications is authorised to expend a total sum of 120,606,571 milreis currency and 11,066,045 milreis gold, but detailed amounts for actual construction works and for the acquisition of material are not separately shown. The Ministry is authorised, however, to grant concessions for railway construction, bridge construction, port improvement works, telephone installations, &c. [Milreis currency at par = 1s. 4d.; milreis gold = 2s. 3d.]

OUR COAL ABROAD.—The following data, illustrating the shipments of steam coal from the United Kingdom in each of the ten years ended with 1915 inclusive, show the severity with which the war has told upon our coal exports. The expression "coal" should be taken also to include bunker coal shipped for the use of steamers engaged in foreign trade, coke, cinders, and patent fuel:—

Year.	Tons.	Year.	Tons.
1906	76,382,417	1911	86,630,072
1907	84,683,086	1912	85,327,216
1908	85,655,521	1913	97,719,906
1909	84,408,171	1914	80,266,101
1910	84,046,065	1915	59,401,108

Shipments were, of course, absolutely suspended last year to Germany, Austria-Hungary, and Belgium. A little British coal (10,324 tons), however, found its way in 1915 to Turkey. The principal exports last year were:—Sweden, 2,639,995 tons; Norway, 2,643,187 tons; Denmark, 3,150,642 tons; France, 17,604,572 tons; Holland, 1,792,951 tons; Italy, 5,788,460 tons; Argentina, 1,618,603 tons; Spain, 2,067,763 tons; and Egypt, 1,388,914 tons. The large increase observable in the deliveries to France is explained by the interruption to the coal-mining industry in the richly-mineralised departments of the Nord and the Pas-de-Calais, which are at present momentarily in the hands of the Germans. It may be interesting to give the shipments of bunker coal separately during the past decade; they were considerably reduced last year by the dislocations and interruptions incident to the war:—

Year.	Tons.	Year.	Tons.
1906	18,590,213	1911	19,264,189
1907	18,618,828	1912	18,291,870
1908	19,474,174	1913	21,031,550
1909	19,713,904	1914	18,535,616
1910	19,528,735	1915	13,630,965

The large contraction observable in bunker shipments has, of course, the compensating advantage of husbanding supplies of British coal available for other purposes.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

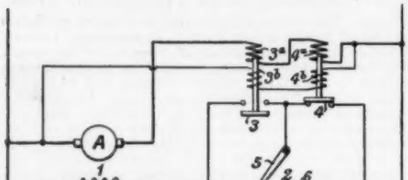
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

ELECTRICAL APPARATUS.

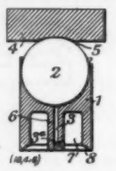
3570/15. Igranic Electric Company, Limited, London. (*The Cutler-Hammer Manufacturing Company, Limited, Milwaukee, U.S.A.*). **Motor-Control System.** [1 *Fig.*] March 5, 1915.—This invention relates to control systems for electric motors and the like. It has particular reference to systems of the type comprising a resistance associated with the field circuit and a pair of relays, of which both are actuated by armature current, and one operates under certain predetermined conditions to include the resistance in the field circuit, while the other operates under other predetermined conditions to exclude the said resistance from the field circuit. The invention comprises a regulable field resistance of which the insertion or removal from the field circuit is controlled by a pair of relays which are both under the control of armature current, but which have each auxiliary means whereby one operates only when the motor is running on power from the line, and the other operates only when the motor is running as a generator. The drawing shows a shunt motor 1 having an armature A and a shunt field winding F. It also shows a conventional form of adjustable field rheostat 2 for regulating the speed of the motor, and two relay-switches 3 and 4 co-acting with the rheostat automatically to regulate the field strength of the motor. The rheostat 2 is shown as comprising a pivoted arm 5 movable over a series of contacts 6 to vary a resistance *r*. When in the position illustrated, the arm short-circuits all of the resistance *r* from the field circuit of the motor, and when moved to the right gradually inserts the resistance in circuit. The relay-switch 3 is normally open and controls a short circuit around that portion of the resistance *r* included in circuit by the rheostat arm 5 when moved to the right. This switch has a winding 3*a* in series with the motor armature, and an auxiliary winding 3*b* connected across the lines. During the acceleration of the motor these two windings act cumulatively to effect closure of the switch 3 whenever the armature current exceeds a predetermined value. Closure of the switch 3 in turn short-circuits the resistance *r* included in the field circuit, thereby strengthening the motor field and effecting a reduction in the armature current. The relay 3 vibrates, alternately excluding and including the field resistance until the motor attains such speed as to enable the field resistance to be



left in circuit without overloading the armature. It thereby protects the motor against too rapid insertion of the field resistance by the rheostat arm. When, however, as often occurs in deceleration, the motor acts as a generator to return power to the lines, the two windings of the relay act in opposition to ensure against response of the relay. The provisions of the two windings for the relay 3 is important, and extremely advantageous for the following reasons: When the motor acts as a generator it frequently occurs that the current generated thereby attains or exceeds the value at which the relay 3 is set to respond in acceleration. Accordingly, should the relay be free to respond, then it would short-circuit the field resistance, increasing the field strength and augmenting the current delivered by the armature. This would be extremely undesirable since the motor requires substantially the same protection against excessive current when acting as a generator as when operating upon power from the lines, and the effect of the relay would be just the opposite of that desired. Provision of the two windings, as aforesaid, however, positively ensures against operation of the relay, and in so doing overcomes the difficulties discussed. In order to provide further protection to the motor when acting as a generator the relay-switch 4 is provided. This switch is normally closed to complete a short-circuit around that portion of the resistance to the right of the rheostat-arm 5. It is provided with two windings 4*a* and 4*b*, which oppose one another when the motor operates upon power from the lines, and which act cumulatively when the motor acts as a generator. Accordingly these windings function in a manner just the reverse of that of relay 3—that is to say, the switch 4 is rendered ineffective during acceleration. When, however, the motor acts as a generator, and the current delivered thereby exceeds a certain value, the two windings act together to open the relay-switch 4 to insert in the field-circuit that portion of the resistance short-circuited by the rheostat arm. This, in turn, decreases the field strength of the machine and thereby effects a reduction of the current delivered by the armature, and so long as the current generated tends to exceed the predetermined value the relay-switch 4 vibrates similarly to the relay 3 to protect the motor. Thus the means illustrated provides for equal protection of the motor under running and generating conditions, and all the danger of interference between the protective means is eliminated by the duplex windings thereof. It is, of course, understood that the windings of the two relays may be of such design as to effect response and inertness thereof at any desired current values. (*Accepted November 3, 1915.*)

HYDRAULIC MACHINERY.

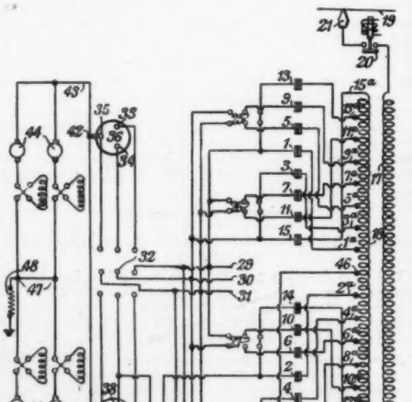
10,416/14. H. S. Hele-Shaw, T. E. Beacham, and F. L. Martineau, London. Hydraulic Apparatus. [2 *Figs.*] October 27, 1914.—This invention relates to improvements in hydraulic apparatus, and has particular reference to pumps and motors of the radial-cylinder type provided with pistons which have balls located in recesses in their heads and passages leading from the recesses to the interiors of the cylinders in which the pistons reciprocate. The present invention consists of a particular construction of such pistons designed to prevent grit and the like contained in the working fluid having access to the balls. Referring to the drawings, the numeral 1 designates a piston provided with a recess to form a seating for the ball 2, and this recess is preferably lined with white metal or the like where the ball actually seats itself and a passage 3 leads from the recess into the cylinder, so that liquid under pressure has access to the ball. The ball co-operates with an eccentrically-situated ring 4, and this ring is preferably provided with a groove or race 5 in which the balls with which all the pistons are provided run. The



size of the balls may be varied within the limits of the cylinder diameter, as may be found desirable or convenient. It is of primary importance that grit should be prevented from reaching the ball, and in order to ensure this the patentees provide a stem 6 centrally of the piston, preferably tapered, and this stem has the passage 3 bored through it from the apex to the ball-seat. Surrounding this stem an annular recess 7 is thus provided, and the wall of the piston is dished or countersunk at its inner end as at 8, so that a comparatively sharp edge is formed where the piston reciprocates in contact with the cylinder-wall, and this edge operates to clean the wall and cause any dirt or grit to be deflected into the annular space in the piston designed to receive it. The orifice in the stem of the piston may with advantage terminate a short distance from the apex of the stem, and a passage or passages, such as 3*a*, at right angles to it, be bored to establish connection between the working fluid and the ball. It will be found in practice that, owing to its greater specific gravity, any grit contained in the working fluid will collect in the annular recess 7 under the influence of centrifugal force. (*Sealed.*)

RAILWAYS AND TRAMWAYS.

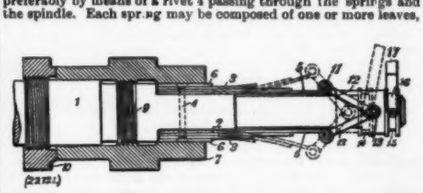
8173/15. The British Westinghouse Electric and Manufacturing Company, Limited, London. Electric Trains. [1 *Fig.*] July 11, 1914.—This invention relates to rectifying systems in which vapour rectifiers are used adapted to be employed in connection with the vehicles of electric railways, and it has for its object to provide a system of the character specified embodying switching arrangements that will permit the use of a plurality of rectifiers either singly or in multiple, together with means for controlling the speed of the vehicle in a simple and economical manner. The invention consists in the combination with a source of alternating current, of a plurality of vapour-rectifying units, a plurality of voltage taps on the source, switching devices whereby any one or all of the rectifying units may be connected to the source through the taps, and switching devices whereby the voltage applied to any rectifying unit may be varied by connecting an anode of that unit to a tap of the



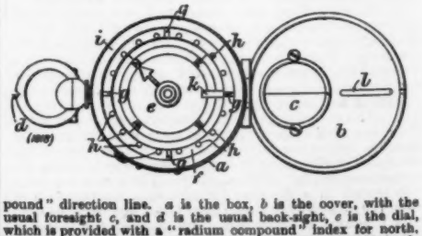
desired voltage before disconnecting the working anode from the tap of initial voltage. One terminal of the primary winding 17 of a transformer 18 is connected to the current-supply lead 19 on the electric railway by means of a line-switch 20 and a trolley 21. The other terminal of the primary winding 17 is connected to the ground as shown at 22. The secondary winding 23 of the transformer 18 is provided with a plurality of taps 1*a*, 2*a*, 3*a*, &c., and each of these taps is connected to one terminal of a contact device 1, 2, 3, &c. The other terminals of contact devices 1 and 13 are strapped together and connected to the two upper terminals of a double-pole, double-throw switch 25. The other terminals of the contact devices 5 and 9 are connected to the centre contacts, respectively, of the switch 25. The two lower terminals of the switch 25 are connected to a pair of bus-bars 30 and 31. In a like manner, a double-pole, double-throw switch 26 is connected to the contact devices 3, 7, 11, 15, and to bus-bars 29 and 31; a double-pole, double-throw switch 27 is connected to contact devices 2, 6, 10, and 14, and to bus-bars 29 and 30; and a double-pole, double-throw switch 28 is connected to contact devices 4, 8, 12, and 16 and to the bus-bars 30 and 31. The bus-bars 29, 30, and 31 are connected, respectively, to the three centre contacts of a triple-pole, double-throw switch 32. The upper terminals of the switch 32 are connected, respectively, to the anodes 33, 34, and 35 of a rectifying device 36, preferably of the mercury-vapour type. The lower terminals of the switch 32 are connected to the anodes 37, 38, and 39 of a rectifying device 40, similar to the device 36. The right-hand terminals of a double-pole, double-throw switch 41 are connected to the bus-bars 29 and 31, respectively; the middle contacts of this switch are connected to the right-hand contact members of the switches 27 and 28, respectively, and the left-hand contacts of the switch 41 are connected to the anodes 37 and 38, respectively, of the rectifier 40. The cathodes 42 and 42*a* of the rectifiers 36 and 40 are connected to a wire 43 leading to the motors 44 of the vehicle, which are arranged in any desired manner, such, for example, as in series multiple. A wire 45 connects the motors to the mid-point 46 of the secondary winding 23 of the transformer 18. The points 47, intermediate in potential between the points 41 and 46, are connected to the ground, preferably through a resistance 48. (*Sealed.*)

STEAM-ENGINES, BOILERS, EVAPORATORS, &c.

22,721/14. The Warwick Machinery Company (1908), Limited, London (*General Electric Company, Schenectady, U.S.A.*). **Speed-Governors.** [4 *Figs.*] November 18, 1914.—This invention relates to speed-responsive devices, such as are used for regulating the speed of prime movers, and its object is to provide a compact instrument, capable of rotation at high speed, and nearly isochronous in its action. The invention comprises a spindle, rotatively connected with a shaft, driven by the machine to be governed, flat springs secured at one end to the sides of the spindle and normally lying flat against it, weights at the free ends of the springs, connections between the springs and the controller of the machine, and means for varying the effective length of the springs. The spindle 1 may be either affixed to or made integral with a rotating shaft driven by the turbine or other machine whose speed is to be governed, or it can be geared to the rotating shaft. The spindle is flattened, preferably on only two sides at 2, to form cheeks, to which are secured the base ends of laminated springs 3, preferably by means of a rivet 4 passing through the springs and the spindle. Each spring may be composed of one or more leaves,



and if more than one, they are laid one upon another. The leaves may be all of the same length or graduated, as shown. In the case illustrated, the inner one 5 is the longest, and the outer one 6 the shortest, and their width also diminishes, because after being laid up they are turned to a cylindrical shape, concentric with the spindle. This is for the purpose of receiving a cylindrical sleeve 7, which can be slid back and forth over the bases of the springs, to lengthen or shorten their effective length. The sleeve is made adjustable, preferably by means of internal screw-threads engaging with a screw-threaded collar 9 on the spindle. A lock-nut 10 on the spindle holds the sleeve in any position to which it may be adjusted. Pivotally attached to pins 11 at the free ends of the inner long leaves 5 of the springs are links 12, which form toggles, whose joints are pivoted to trunnions 13 on a collar 14. The latter slides freely on the spindle, and has a groove 15, with which engages the fork 16 of a lever 17 connected to the controller of the machine. When the spindle is rotated, the pins 11 and the ends of the links 12, pivoted to the leaves 5, act as centrifugal weights and tend to fly outward. This tendency is aided by the weight of the free ends of the spring, but is yieldingly opposed by the elasticity of the springs. (*Sealed.*)

MISCELLANEOUS.

1818/15. Francis Barker and Son, Limited, and E. W. Barker, London. Magnetic Compasses. [1 *Fig.*] February 4, 1915.—This invention relates to magnetic compasses, and particularly to those employed for night-marching, mine-surveying, and like operations, which have a fixed setting-scale and are provided with luminous index and north indicator. According to this invention, an annular scale of degrees is fixed in the box, and the scale is rendered visible by night by the use of "radium compound," applied at the four cardinal points in the form of a line, and at every twenty (or more or less) degrees in the form of a dot or spot. The scale is protected by the cover-glass, which carries an index, provided with "radium compound," the glass being mounted in a bezel, which is rotatable about the box. The dial is provided with a "radium compound" index for north, and the lid or cover is provided with a "radium compound" direction line. *a* is the box, *b* is the cover, with the usual foresight *c*, and *d* is the usual back-sight, *e* is the dial, which is provided with a "radium compound" index for north, and floats preferably below the level of an annular setting-scale of degrees *f*, which is fixed in the box. The scale is rendered visible by night by the use of "radium compound," applied at the four cardinal points in the form of a line (as indicated at *g*), and at every twenty degrees or so in the form of a dot or spot, as indicated at A. The box is provided with the usual cover-glass, mounted in a bezel *i*, which is rotatable about the box, the cover-glass serving to protect the annular setting-scale and carry the index *k*, which is rendered luminous by "radium compound. The direction-line *l* in the cover *b* is also provided with "radium compound." It will thus be seen that every requisite for setting off the scale and other usual daylight manipulations is provided in the box and rendered visible for performing similar manipulations in the dark. (*Accepted November 10, 1915.*)